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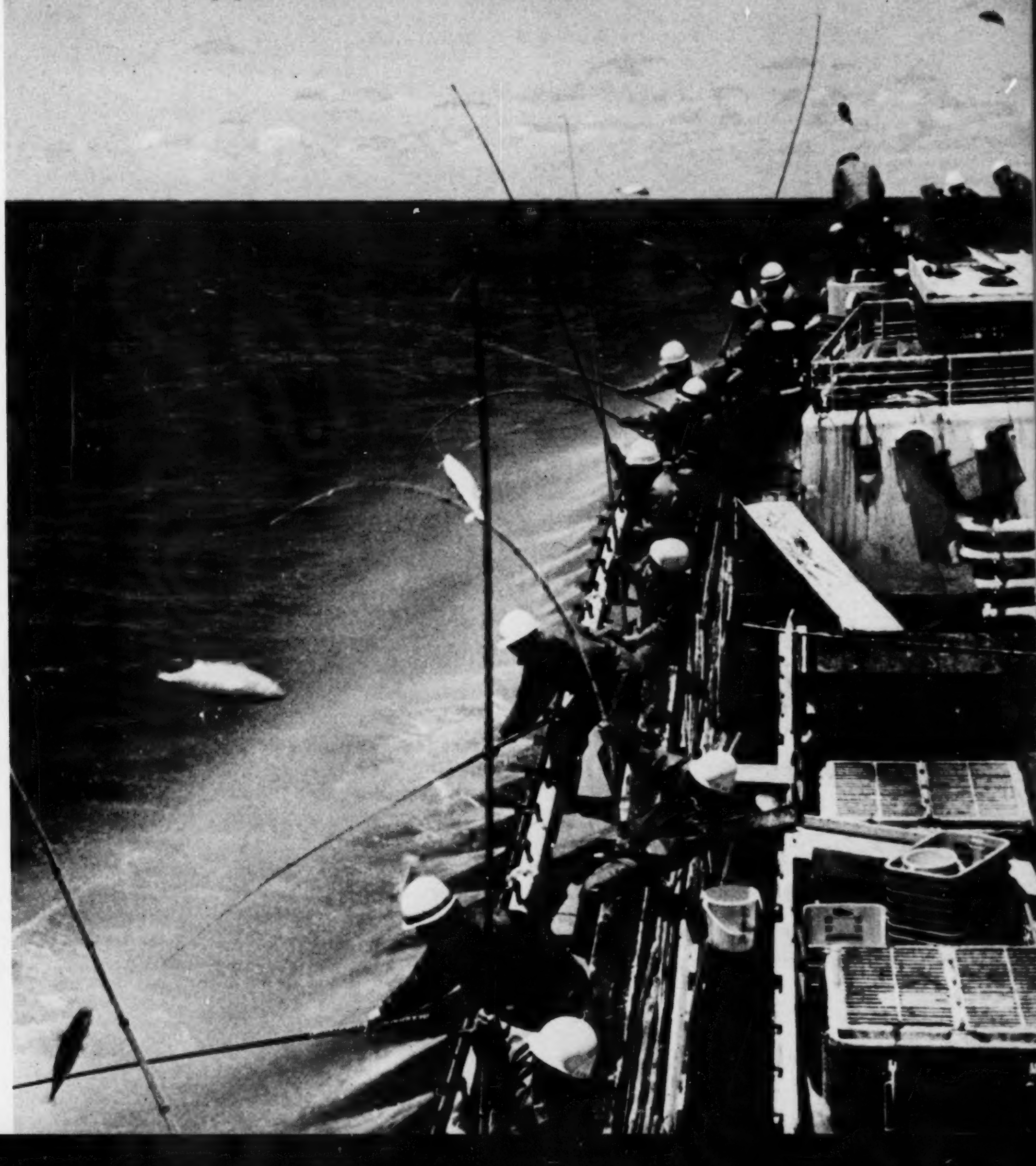
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

The Skipjack Era--A Japanese View



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Cover.—*No. 15 Hōkō Maru* (Hōkō Suisan Company, 315 tons) in central North Pacific skipjack operation, July 1972. Photograph by Hiroyo Koami, Institute of Sea Sphere and Tsukiji Fish Market Company, Tokyo.

U.S. DEPARTMENT OF COMMERCE
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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National Marine Fisheries Service

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MFR PAPER 977

An eminent Japanese scientist urges a closer look at "the skipjack era."

The Skipjack Tuna Resource *(Katsuo no Shigen ni Tsuite)*

TSUYOSHI KAWASAKI

As the demand for skipjack tuna has increased in Japan, Japanese interest in the skipjack resource has also grown. While other tuna resources are considered to have reached the level of maximum sustainable yield, it is generally believed that the skipjack resource is relatively unutilized and that there is a great development potential. With the advent of the southern fishery, it has become possible to fish for skipjack tuna on a year-round basis, thereby increasing production.

FISHERY AND DISTRIBUTION

According to the Food and Agriculture Organization of the United Nations (FAO) statistics on world skipjack landings (statistics not shown in text but given as a separate table in this same issue of Suisan Shūhō on page 158), there was a marked increase in landings around 1966. [Translator's note: The total landings in 1964 and 1965 are given as 267,000 and 251,000 tons, respectively.] Since 1966, the annual landings have been at the 300,000-ton level. Although this is largely due to increased landings by Japanese vessels, there have also been increased landings in the central eastern Atlantic by vessels from France, Ghana, Japan, Senegal, etc. There have been no noticeable differences in skipjack production in other areas.

Skipjack fisheries are not distributed evenly. Although the total world catch of skipjack is approximately 300,000 tons, about two-thirds of this catch is being taken from the northwestern Pacific by Japanese vessels. The operating range of Japanese vessels extends from lat. 45°N to the equator in the western Pacific (west of long. 160°E). The bulk of the landings is, however, made in a relatively narrow area of the western Pacific north of lat. 30°N. The area producing the next largest catch is the coastal waters of the eastern Pacific extending from Baja California to northern Chile, where 50,000 to 100,000 tons of skipjack are landed each year. Although there are skipjack fisheries in the Atlantic and Indian Oceans, their landings are quite small.

The skipjack tuna are described in English as "cosmopolitan," because they are very widely distributed. It is said that skipjack can be found in all the warm seas, wherever the water temperature is above 20°C. In biological terms, skipjack may be described as a highly adaptable species. While the fish are widely distributed, their fishing grounds are found only in very limited areas. Various reasons can be given for this, but one of the important ones concerns the problem of live-bait supply.

RESOURCE STRUCTURE

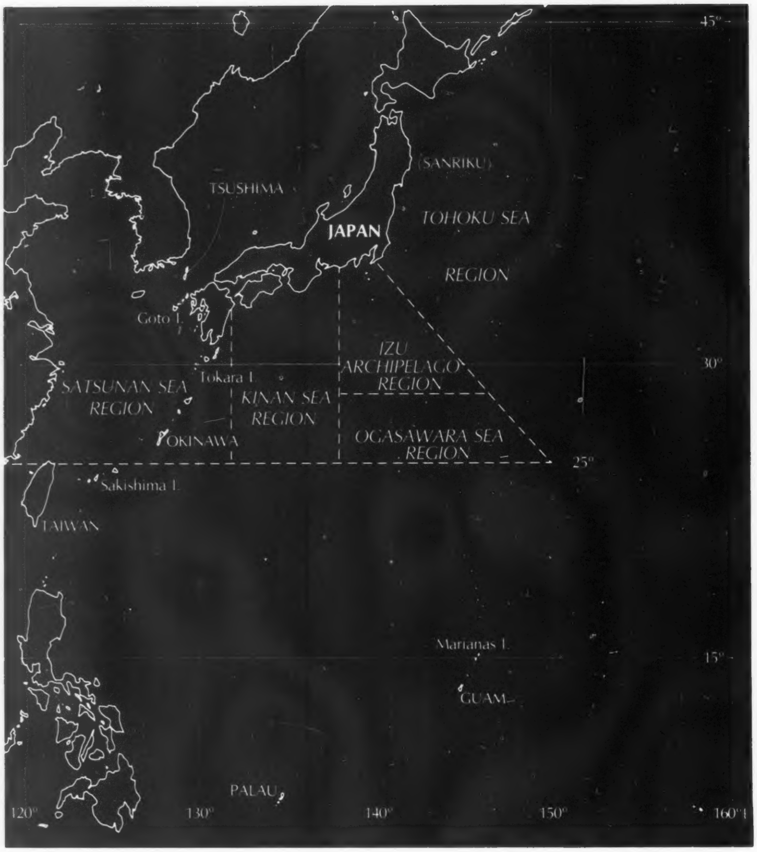
As mentioned previously, little skipjack fishing is done outside the Pacific Ocean. Consequently, research on this resource has been virtually limited to the Pacific.

Skipjack begin spawning when they attain a body length of 40-45 cm. The number of eggs spawned differs with size of the spawning fish, but appears to range from 100,000 to 2,000,000 eggs. These fish are multiple spawners, spawning several times during a season. There are 4 days between fertilization of the egg and hatching, and the newly hatched larvae are from 2.5 to 3.0 mm long.

The larvae of skipjack are distributed widely in both the Pacific and Indian Oceans (Figures 1 and 2). In the Pacific they occur in greater numbers in the west, where latitudinal distribution is also much wider. In spite of this latitudinal range, however, most of the larvae are found in equatorial waters between lat. 10°N and 10°S, and the principal spawning area in the Pacific is located in western equatorial waters. Distribution reflects oceanographic conditions, and virtually no larvae are found in waters with surface temperatures lower than 24°C.

The larvae are rather plentiful in waters near Japan during the summer, but to the south there is a progressively larger proportion of larvae occurring in winter. In equatorial waters, larvae are found throughout the year. The ratio of skipjack larvae, relative to total tuna

Tsuyoshi Kawasaki is Chief, First Resource Section, Tokai Regional Fisheries Research Laboratory, Fisheries Agency of Japan. This paper appeared in *The Fishing and Food Industry Weekly (Suisan Shuho)* No. 660, p. 32-38, July 15, 1972. The translation, by permission of the author, was made by Tamio Otsu, NMFS Southwest Fisheries Center, Honolulu Laboratory. A distinguished scientist in his own right, Otsu is perhaps best known for his studies of the transpacific migrations of the albacore.



larvae, is approximately 3 to 4 in waters west of 180° and south of lat. 25°N.

Skipjack tuna are 15 cm long at age 1, 45 cm at age 2, 63 cm at age 3, 73 cm at age 4, and 77 cm at age 5. The skipjack which originate in equatorial waters gradually spread out. At age 2, they have reached their widest distribution, having migrated to the eastern Pacific as well as to Japanese waters such as off Sanriku (Tohoku sea region).

The 3-year-old fish are not as widely distributed as are the 2-year-olds, but in Japanese waters they are found in such areas as the Izu Archipelago and Satsunan sea regions. At age 4 and older, the fish return to the equatorial region to spawn. The skipjack that migrate into Japanese coastal waters are probably fish that originate in northern summer spawning. It is believed that fish originating in southern summer spawning distribute themselves in the South Pacific.

The skipjack arrive in Japanese waters in the spring. They enter the Tohoku sea region, Izu Archipelago region, and Satsunan sea region, remaining there until fall with relatively little interchange between areas. Recently, the Tohoku Regional Fisheries Research Laboratory conducted large-scale tagging in waters south of the Sakishima Islands (Ryukyu Islands). Although there were year-to-year differences, a large proportion of the tagged fish were recaptured in the Satsunan sea region. Tagged fish which migrated into the Izu Archipelago and on into the Tohoku sea region comprised only about 10% of the total tag recoveries (Table 1).

Among fishes in general, each species may be divided into a number of subpopulations. A subpopulation consists of fish with a separate spawning area and whose progeny do not freely intermingle with progeny from other subpopulations. The subpopulation represents essentially an independent unit.

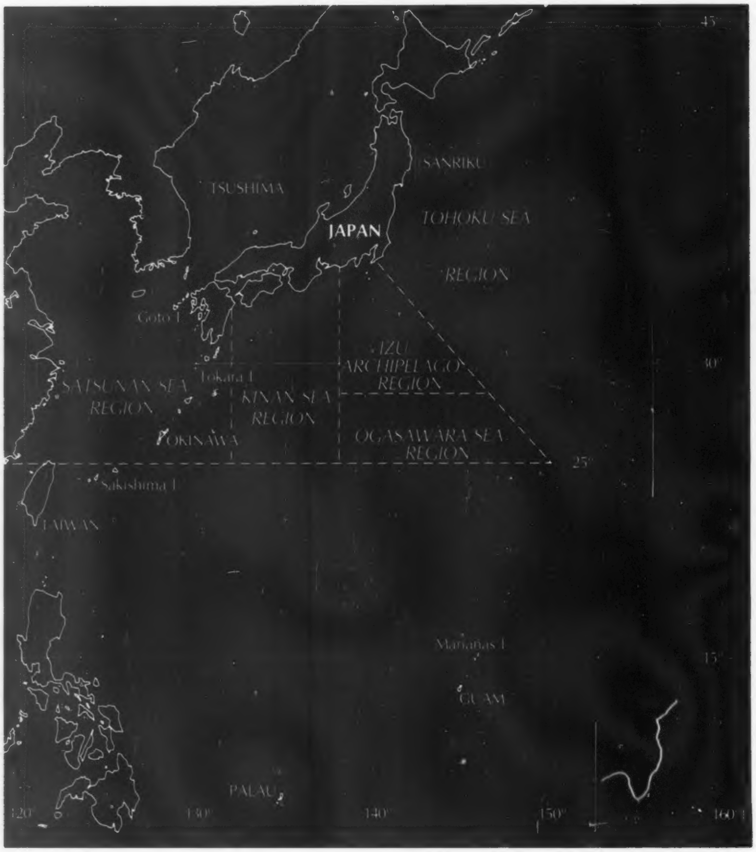
For example, the mackerel ("masaba") of the Japanese waters can be clearly separated into those related to the Kuroshio and those of the Tsushima Current. There is virtually no interchange between the two groups, and these groups are considered separate subpopulations.

It is vitally important to clarify the subpopulation structure of a resource before proceeding with estimates of fishing conditions, or with assessment of the resource.

With regard to the skipjack tuna of the Pacific, there appears to be very little spawning taking place in the eastern part of the ocean. Fish tagged off Baja California have been recovered off Hawaii as well as off Christmas Island (Figure 3). These facts indicate that at least those skipjack which occur off Baja California originate in the central Pacific. The problem is to clarify the areas of origin of fish that migrate in Japanese coastal waters.

The skipjack landings in the eastern Pacific, Hawaii, and the Tohoku sea region show considerable similarity in annual fluctuations. Also, judging by the winter skipjack catches of longline vessels, it is clear that the fish are distributed continuously between Japan and Hawaii. From these facts, I first proposed that the equatorial waters between long. 160°E and 140°W are the common spawning area of the skipjack, or in other words, their place of origin. However, it is now obvious that the western limit at long. 160°E was in error, and that the spawning area is probably between long 120°E and 140°E. In any case, I hypothesized in 1964 that all Pacific skipjack had a common source.

Regarding this problem, Dr. Fujino (Dr. Kazuo Fujino) at the Biological Laboratory in Hawaii (presently with



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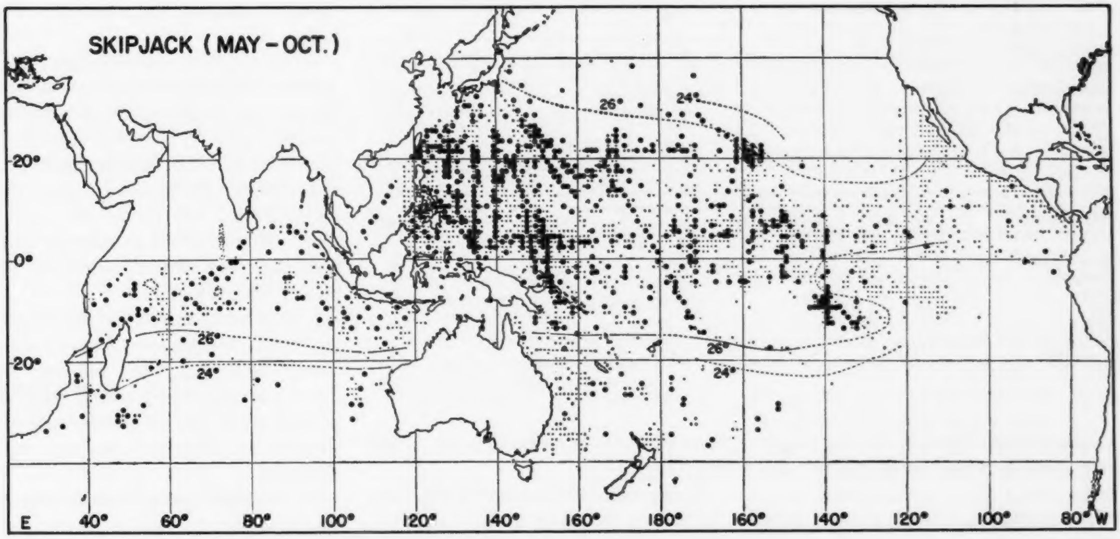

Figure 1.—Areas where skipjack larvae were collected during May-October (from Ueyanagi, 1969). Large dots indicate larvae present, small dots indicate larvae absent; dotted lines indicate 24° and 26°C surface isotherms.

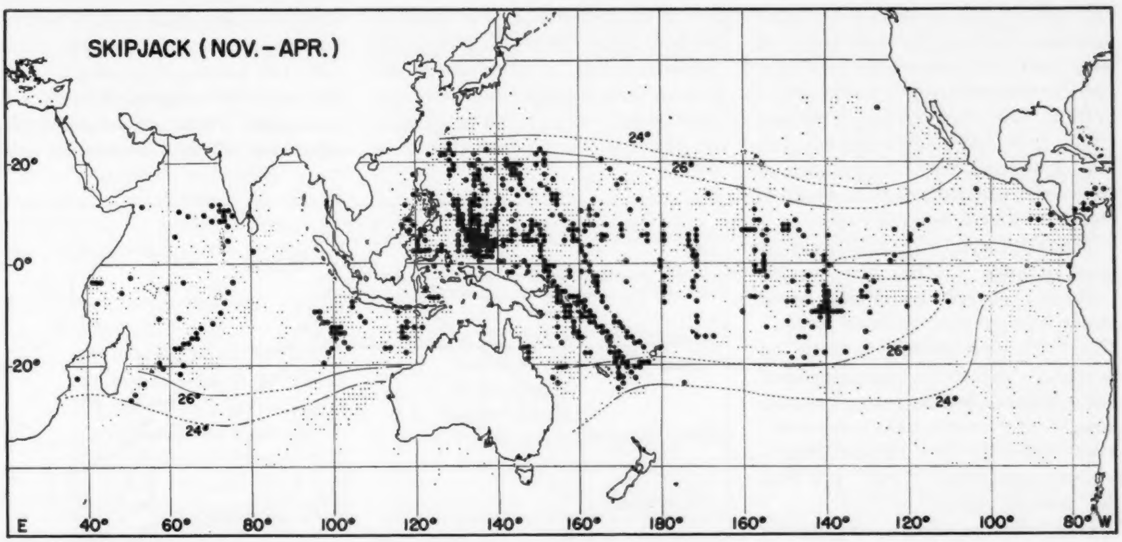

Figure 2.—Areas where skipjack larvae were collected during November-April (from Ueyanagi, 1969). Large dots indicate larvae present, small dots indicate larvae absent; dotted lines indicate 24° and 26°C surface isotherms.

the Kitasato University in Japan) concluded, on the basis of serological studies, that the western Pacific skipjack belong to a subpopulation separate from fish of the central and eastern Pacific (the latter belonging to one or more subpopulations). The boundary was reported to be near the international dateline and thus fish distributed in Japanese coastal waters, the Marianas, and Palau would be separate from those occurring off California, in Tahiti, the Line Islands, and Hawaii. Furthermore, it was suggested that in the Tohoku sea region, the fish of the western Pacific subpopulation are replaced in the early fall by fish of the central-eastern Pacific subpopulations.

Table 1.—Recoveries of skipjack tagged by the *Miyazaki Maru*, by month and sea area (from Kasahara et al., 1971).

Sea area/1968	Mar.	Apr.	May	June	July	Aug.	Sept.	Total
South of 25°N	—	—	—	1	—	—	—	1
Satsunan	—	15	30	12	13	3	—	73
Kinan	—	—	1	—	—	—	—	1
Izu	—	—	—	4	—	—	—	4
Tohoku	—	—	3	—	1	—	—	4
Total	—	15	34	17	14	3	—	83
Sea area/1969	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Total**
South of 25°N	3	1	—	—	—	—	—	4
Satsunan	—	3	3	—	2	2	3	13
Kinan	—	1	4	1	—	—	—	6
Izu	—	—	1	—	—	—	—	1
Tohoku	—	—	—	—	2	—	1	3
Total	3	5	8	1	4	2	4	27

In other words, Fujino postulated separate areas of origin for the Pacific skipjack.

From length-frequency data it can be shown that two groups of skipjack are present among the 2-year-olds which appear in Tohoku waters during August. For example, as may be seen in the 1951 data (Figure 4), there is a marked difference between fish taken west of long. 154°E and those taken east of long. 156°E, with modal lengths differing by 5 to 6 cm. There is a mixture of the two groups in the intermediate area between long. 154°E and 156°E. An intrusion of cold water originating in the Oyashio characterizes this boundary area.

Those fish found in the offshore areas (east of long. 156°E) were labeled "offshore group" and those found closer inshore the "inshore group." The "offshore group" is made up largely of "sumure" or unaccompanied fish, while the "inshore group" consists largely of "sametsuki" or shark-associated fish. The "offshore group" is also composed of "fatter" fish than the "inshore group."

The "offshore group" disappeared abruptly from the fishing grounds after 1952. It finally reappeared in 1958, and from July to the end of the fishing season these fish occurred indiscriminately in coastal and offshore waters, being taken as readily as fish of the "inshore group," generally the principal component of the catch. This occurrence was not typical, but probably reflected the particular sea condition existing during that year.

In any case, it had long been known that a separate group of fish existed in offshore waters of the Tohoku sea region. It was Fujino's findings, however, which suggested that this may be a group of fish possessing different genetic characteristics. The problem now is to determine whether or not the "offshore group" is composed of fish from the same subpopulation as the "inshore group" with certain heterogeneous characteristics, or whether these groups belong to separate subpopulations.

Even within the narrow limits of the Japanese coastal fishery, the skipjack resource is made up of at least four groups:

1. Migratory fish that appear near the Goto Islands (Satsunan sea area) from summer to fall. These are largely 2-year-old fish whose growth is exceedingly rapid and whose gonads are completely undeveloped.

2. The shoal-associated fish appearing in the Tokara and Okinawa areas. These are 2- and 3-year-old fish. The 2-year-olds are slow growing. Both age groups show sexual development in summer and appear to undergo some spawning.

3. The third group occurs virtually year-round in the shoal areas of the Izu and Ogasawara sea regions. The fish generally resemble those in the Tokara and Okinawa areas, and also undergo some spawning in summer. The 3-year-olds are rather small early in the year but tend to grow very rapidly.

4. The fourth group consists of migratory fish that appear in the Tohoku sea region. These fish resemble those appearing off the Goto Islands, and

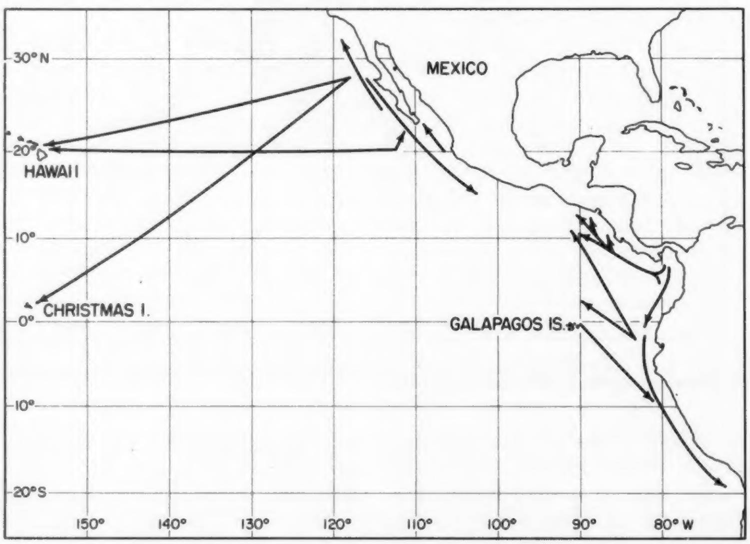

Figure 3.—Results of skipjack tagging in the central and eastern Pacific.

most are 2-year-old fish showing evidence of very rapid growth. Their gonads are completely undeveloped.

These groups, with differing ecological characteristics, are believed to result from environmental differences. In other words, it is thought that although they are of common origin, the 2-year-old fish which migrate into Japanese coastal waters in the spring develop their characteristics depending on whether they first enter open-sea or shoal environments.

ASSESSMENT OF THE RESOURCE

As mentioned earlier, strong sentiment exists today regarding the tremendous potential of the skipjack resource. According to "On the possibility of developing marine fishery resources" issued by the Fisheries Agency of Japan in June 1968, the potential for increased skipjack production is as follows:

1. Coastal fishing grounds—Pacific
   With the development of purse seining techniques, it should not be too difficult to increase landings from Japanese coastal waters by two or three times the present landings, or an increase of 200,000 to 400,000 tons.
2. Offshore fishing grounds
   a. Pacific
      Considering the entire Pacific, the present catch of about 500,000 tons [Translator's note: This figure probably includes landings of species such as *Sarda, Auxis,* etc.] can probably be increased to at least 1,000,000 tons.
   b. Southwest Pacific
      Development of fishing grounds around Indonesia and the South Pacific islands can be anticipated.
   c. Indian Ocean
      New fisheries producing 200,000 to 300,000 tons can be anticipated.

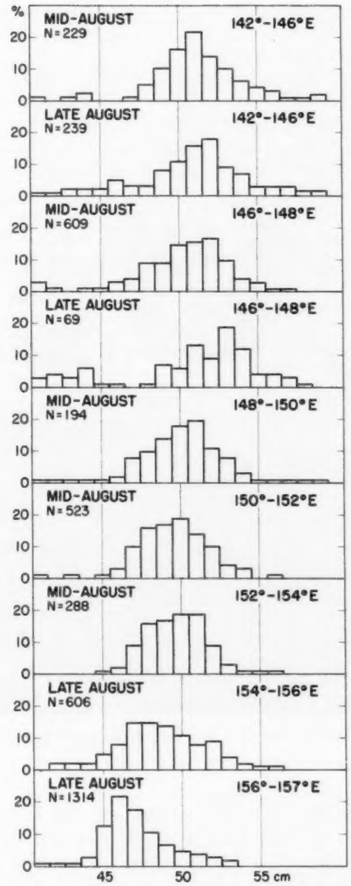

Figure 4.—Length-frequency distributions of skipjack tuna, by longitudes, in the Tohoku sea area during 1951.

   d. North Atlantic
      Landings of 100,000 tons can be expected.
   e. South Atlantic
      Landings of 100,000 to 150,000 tons can be expected.

If the various estimates are totaled, the potential skipjack yield would amount to 1.6 to 2.0 million tons, or five or six times the present landings.

In "Basic data relating to marine resources of the future" issued by the Science Technology Agency in July 1971, the following was included:

> "The skipjack spawn chiefly in tropical and subtropical waters, but there is also some spawning in temperate waters. Thus, skipjack spawn over a very extensive area. Also, skipjack juveniles appear in large numbers in stomachs of other tunas and billfishes which inhabit the same waters, as do the skipjack. It can be assumed from these facts that the skipjack resource is at least several times as great as the resource of the other tunas and the billfishes. In spite of this, the skipjack catch from both offshore and coastal waters in 1968 amounted to a mere 190,000 tons."

If we take these various estimates into consideration, it appears that the skipjack resource is capable of a severalfold increase in landings.

At the June 1971 conference of the Japan Fisheries Resources Convention Association, Dr. Suda of the Far Seas Fisheries Research Laboratory commented as follows:

> "The number of skipjack larvae collected in past studies is 1.7 to 1.8 times that of other tunas. The quantity of adult skipjack should be correspondingly large. There are also very large numbers of skipjack juveniles found in stomachs of large tunas and billfishes. They number five to ten times more than juveniles of all the other tunas. Considering the ecological differences between skipjack and other tunas, it seems appropriate to use the frequency of appearance of larvae as a basis for estimating the spawning stock. According to this, it would appear that the volume of skipjack spawning stock is 1.7 to 1.8 times that of the total of all the other tunas. Considering also that the relative occurrence of juveniles in the stomach contents is so much greater, it would probably be reasonable to assume a skipjack spawning stock which is about twice that of the other tunas.
>
> "The annual production of large tunas from the Pacific is 400,000 to 500,000 tons. Thus, we can very roughly estimate the potential production of skipjack tuna in the Pacific at between 800,000 and 1,000,000 tons.
>
> "Furthermore, judging by the ocean area [Translator's note: Probably of areas suitable for skipjack] in the Atlantic and Indian Oceans, we believe that there is a standing stock of 200,000 to 400,000 tons of skipjack in each of those oceans."

No. 2. Fukukyu Maru **of Yaizu in central Northern Pacific skipjack operation, July 1972. Photograph by Hiroyo Koami, Institute of Sea Sphere and Tsukiji Fish Market Company, Tokyo.**

Turning now to outside Japan, in 1966 Dr. Rothschild of the Biological Laboratory in Hawaii used the Beverton-Holt method to estimate the potential yield of skipjack tuna in the central Pacific Ocean. He stated that:

> "If the skipjack that migrate from the eastern Pacific fishing grounds into the central Pacific are harvested, the potential yield would be 2 to 17 times the present eastern Pacific yield of 68,000 tons. Since there are skipjack in the central Pacific that do not enter the eastern Pacific, the potential yield in the central Pacific may be even greater."

Such emphasis on the great potential of the skipjack resource has resulted in accelerated research aimed at resource development, and scientists of the Tohoku Regional Fisheries Research Laboratory, who have a long history of skipjack studies, have voiced some concern over this "development mood" now prevailing. At the June 1971 Skipjack Fishing Condition Evaluation Conference, Dr. Ishida (Tohoku Laboratory) made the following remarks:

> "Because of the stagnation in the tuna longline fishery, interest has turned to skipjack tuna. Government authorities hold high expectations that this is now the era of the skipjack. However, particularly in southern waters, which are the source of coastal water skipjack, our studies indicate that school sightings are unexpectedly few, and fishing was indeed poor last year. It is necessary to clarify whether or not the skipjack resource might already be declining as are the other resources."

Also, Dr. Kasahara (Tohoku Laboratory) reported in October 1971 [Suisan Sekai 20(10)] the following:

> "While the fishing effort is on coastal water skipjack, its effect on the resource should not be very great. However, the fishing effort in the southern waters, which is the base of the skipjack distribution, may have some direct effects on the resource, perhaps affecting its reproductive capacity or its recruitment potential. The skipjack resource is believed to hold considerable potential for development. It is believed that skipjack will replace the larger tunas which are already at a level of maximum production. However, research on skipjack is not sufficient at present. Even the estimates of the resource size appear to be in need of further evaluation. Even if the resource is as large as estimated, it is certainly not inexhaustible. In order not to let the skipjack resource follow in the footsteps of some other unfortunate species, it is desirable to base its utilization on sound considerations."

Kasahara further noted that for one area of the southern fishery subject to

considerable fishing effort, the catch per day's fishing has decreased rather markedly from year to year. However, the average catch per day's fishing in the southern fishery as a whole did not show such a noticeable decrease, during the same period, which indicates that in addition to the principal fishing grounds, new grounds are being discovered from time to time, resulting in a stabilized overall catch rate.

Thus, regarding the development potential, there is some difference between the general optimistic view and the more cautious views of the Tohoku Laboratory scientists. Let us further examine this matter. In 1965 I presented my views on this subject in my paper, "Skipjack ecology and resource," as follows:

> "I believe that the skipjack resource as a whole has considerable potential. This can be seen from the following:
>
> "1. Among the skipjack and other tunas which inhabit the Pacific Ocean, the skipjack resource is the largest. For example, of the juveniles of skipjack and other tunas occurring in stomach contents of tunas and billfishes, a significant proportion consists of skipjack. Also, among the tunas, skipjack are the most adaptable to varying environmental conditions (generally, fish species that are most adaptable to their environment tend to be more abundant).
>
> "2. The principal skipjack fishing grounds are the Japanese coastal waters and the waters of the eastern Pacific, both of which are on the fringes of the skipjack distribution. The skipjack taken are largely of only one or two age groups.
>
> "3. Other than in Hawaii, there are no fisheries which exploit principally the spawning group of skipjack.
>
> "4. The Japanese coastal fishery that takes the most skipjack is a pole-and-line fishery. This method relies heavily on the physiological response of the fish.
>
> "I emphasized that there is a vast difference between the potential size of a resource and its potential production.
>
> "Figures are very definite. Regardless of the numerous assumptions that go into making these estimates, once a figure is advanced, it tends to stand by itself. As Kasahara has stated, it is difficult to accept the accuracy of the estimates of the resource size. Take Suda's estimate, for example. To say that the skipjack resource is twice the size of all other tunas resources combined simply because there are twice the number of skipjack larvae appears to be rather an oversimplification. It would appear necessary to at least consider that skipjack differ greatly from other tunas in average body weights."

Today, when "development of undeveloped and under-utilized resources" is one of two principal themes of our fishery policy, there is an inclination toward increased production without due regard for "efficient utilization" of the resource.

We should avoid the same serious situation that has overtaken other tuna fisheries. "If there are no other tunas, there is still the skipjack" is an expression that should be eliminated. What is now necessary is to conduct a thorough study of the resource structure and condition. Specifically, it would be desirable to conduct large-scale tagging on skipjack of the Tohoku sea region and in the southern fishing grounds. It should not be too late to begin the move to increase production after attaining a thorough knowledge of the resource.

It is now becoming an international trend to advocate the rational use of living resources (e.g., whale resources, at the Conference on the Human Environment held in Stockholm). Rather than go ahead with development and perhaps regret later, it is better to base the development on sound scientific grounds.

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[1]Added by Translator.

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MFR PAPER 978

At Seattle, emphasis is being put on the pathways in which contaminants reach marine organisms and the mechanisms through which they induce lethal and sublethal effects.

Northwest Fishery Center Research on Effects of Environmental Contaminants on Marine Organisms

MAURICE E. STANSBY and DAYTON LEE ALVERSON

INTRODUCTION

During the past several years, the National Marine Fisheries Service (NMFS) and its parent organization, the National Oceanic and Atmospheric Administration (NOAA), since their creation, have become involved with problems concerning environmental contaminants and their effects on aquatic life. In order to respond in an effective way to this mandate, the NMFS Northwest Fisheries Center, Seattle, has taken certain steps to realign its programs in order that appropriate information be developed concerning the effects contaminants have on fish and shellfish organisms. In addition to standard baseline investigations which are a part of many programs, heavy emphasis is being placed on investigating various pathways in which contaminants reach marine organisms and the mechanisms through which they induce lethal and sublethal effects. These investigations have been organized at the Northwest Fisheries Center under a newly established division—the Environmental Conservation Division.

Much of the literature and press releases concerning contaminants harmful to aquatic life have been stimulated by the analysis of the levels of various contaminants found within the flesh of fish and shellfish. The basis of such studies frequently has been concerned with the suitability of fish for human consumption. Associated with these investigations has been the erroneous overt or inadvertent implication that when the amounts of contaminants in fish (such as DDT and mercury) exceed the level deemed safe for human consumption, the contaminants must be doing exceedingly harmful things to the animals themselves and, perhaps, threatening the existence of important fishery stocks.

Such conclusions are seldom valid. The presence of contaminants in fish far in excess of that considered safe for human consumption tells us nothing whatsoever regarding what is harmful to the fish. Quite different approaches than mere analytical surveys are needed if we are to tell the damage—if any—caused by the residue of contaminants in the flesh of fish. Hence, the primary aim of the program at the NWFC is to assess the physiological or biochemical damage resulting from different levels of contaminants which may be incorporated through various mechanisms into marine organisms.

In order to achieve these aims, a multidisciplinary approach to the problem involving fishery biologists, biochemists, physiologists, toxicologists, histopathologists, pharmacologists, microbiologists, geneticists, and bioengineers will be required. Not all of these disciplines are available within the Center; however, such skills are available in other government agencies, universities, private enterprise, etc.

STATUS OF RESEARCH

In recent years a considerable number of research projects in various laboratories have attempted to assess the effects of contaminants in the environment upon fish. Much of this work has dealt with pesticides, particularly DDT. Unfortunately research of this character has frequently employed levels of pesticides far above those which fish would ordinarily encounter in nature, and the results are often meaningless or difficult to interpret in any practical situation. DDT occurs in the open ocean at levels far less than one part per trillion. In special areas of the ocean, such as near sewage outfalls and especially in layers of such water near the surface, the DDT content is frequently above this level but the levels even here are under 100 parts per trillion, usually much under this figure, and ordinarily not above 5 to 40 parts per trillion. This includes both DDT dissolved in the water or adsorbed upon surfaces of material in the water and that contained in the fats of marine organisms (fish, plankton, etc.) inhabiting the water. Yet in many experimental studies conducted over the past 15 years or so, the amount of DDT used in the water in which the experimental fish have been studied has usually been in

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parts per million rather than parts per trillion. This means that the fish have often been exposed to a million times as much pesticide as they would encounter in the normal environment. The only situations where such high levels could even be approached are situations such as fish passing a source of contamination such as a discharge pipe from a pesticide plant, before mixing took place, or in an isolated water system such as a small lake or small stagnant inlet from an estuary where dilution is retarded. Such situations are not only rare but should be rapidly eliminated during the early stages in implementation of new water quality standards.

We cannot apply results of effects of contaminants at abnormally high levels (thousands or millions of times above normal) by extrapolation because of the discontinuous nature of the effects of toxic or nutritional components of the diet. Most nutritional components of the diet, whether it be for fish, animals, or humans, are effective at certain levels, but if the level is sharply increased, the nutrient often becomes toxic. This is true of certain vitamins, e.g., vitamins D and A, where increasing the amount consumed by only a few hundred times above normal can cause disease or death. Even nutrients like common salt or sugar when increased only a few fold over normal requirements are harmful. Thus to try to assess the effect of contaminants in the water upon fish by using levels of the order of a million times that occurring naturally is quite meaningless. It seems increasingly important, therefore, that we concern ourselves with the long-term effects of contaminants at levels existing in the average waterways either at coastal and estuarine areas or in the open sea.

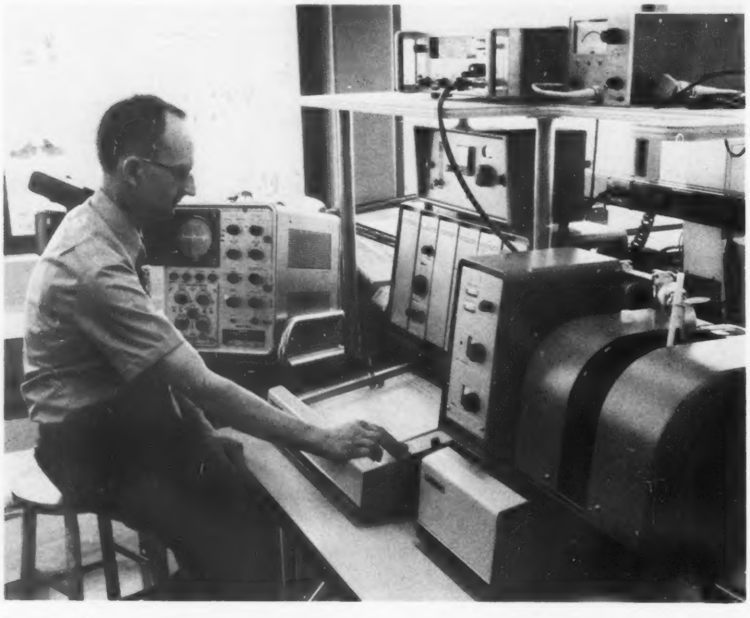
Some of these poorly designed experiments doubtlessly reflect a failure to understand that there is a huge difference in effects where the contaminants are exposed to the fish, dissolved or suspended in the water, as contrasted to effects of the fish feeding upon other fish or organisms such as plankton which contain the contaminant. Contaminants presented to fish in the water affect the fish's respiratory system where they are harmful at far lower levels than would be the case in the fish's food. Fish can easily tolerate several parts per million of such contaminants in their food where the contaminants are transferred quickly to depot fats where they can be stored in an inert form. By contrast such contaminants at only 1/1000 of this level (i.e., parts per billion) can severely damage or kill fish as a result of entering through the gills and adversely affecting respiration. Most of the research done to date has involved pesticide levels at concentrations suitable only for experiments involving the fish's food.

The unmanned troopship *General M.C. Meigs*, while under tow, broke loose and went aground on the northwest coast of Washington in January 1972. Scientists from several agencies have since made repeated studies of the effect of leaking fuel oil on the animals and plants of the intertidal community. Urchins appear to have been particularly affected. Here Robert C. Clark, Jr., NMFS Northwest Fisheries Center (kneeling), and Edward E. DeNike, Washington State Department of Ecology, examine the scene. The wreckage of the vessel is in the background. Photograph courtesy of *Seattle Times*.

ROLE OF NWFC

New studies initiated at the NWFC will employ contaminants presented to fish in their feed at levels (parts per million) comparable to those encountered by fish in their natural environment, and in such cases where we may choose to investigate the effects of contaminants in the water, we will restrict levels to parts per trillion. In many studies the contaminants have been added to the feed by first dissolving them in some appropriate solvent and then either spraying this solution onto the feed or dipping the feed in the contaminant solution. This procedure results in a *mixture* of contaminant and feed where much of the contaminant is not dissolved in the fatty portion of the feed but rather is loosely held at the surface. Under such conditions some of the contaminant will be washed into solution when the feed is added to the fish aquarium and may then be in part available through the gills as well as through the feed. In order to eliminate this potential source of error we plan to use a system employed recently in several research investigations where the feed is obtained in part by culturing marine organisms, e.g., mussels, shrimp, or some type of plankton grown in water to which the contaminant has been added. These marine organisms used as food will then contain the contaminant in the natural form occurring in the food chain.

In initial investigations contaminants to be studied will include the pesticide endosulfan, PCB's (polychlorinated biphenyls), and petroleum oil components. Endosulfan is a chlorinated hydrocarbon and it is one of the principal pesticides which is to be substituted for DDT for spraying fruit orchards in the Pacific Northwest. These orchards are located adjacent to the Columbia River and tributary streams where a portion of the pesticide may be washed into rivers and streams or reach them via airborne routes. PCB's are, of course, ubiquitous and we need to know more about their effects on fish under conditions prevailing in the natural environment. Petroleum oil up until now has not been a major pollutant in waters of the Pacific Northwest. Several refineries have been in operation on Puget Sound which may have tremendous expansion of their operations when and if large petroleum oil shipments are made from the Alaskan North Slope region. Present planning would call for a considerable portion of the refining of such oil in plants in Northern Puget Sound. This would increase the hazard of large oil spills in the future. Currently, and for the past several years, NWFC has had a small-scale monitoring program under way to determine baseline levels of hydrocarbons (one component of petroleum oil) in marine organisms of Puget Sound.

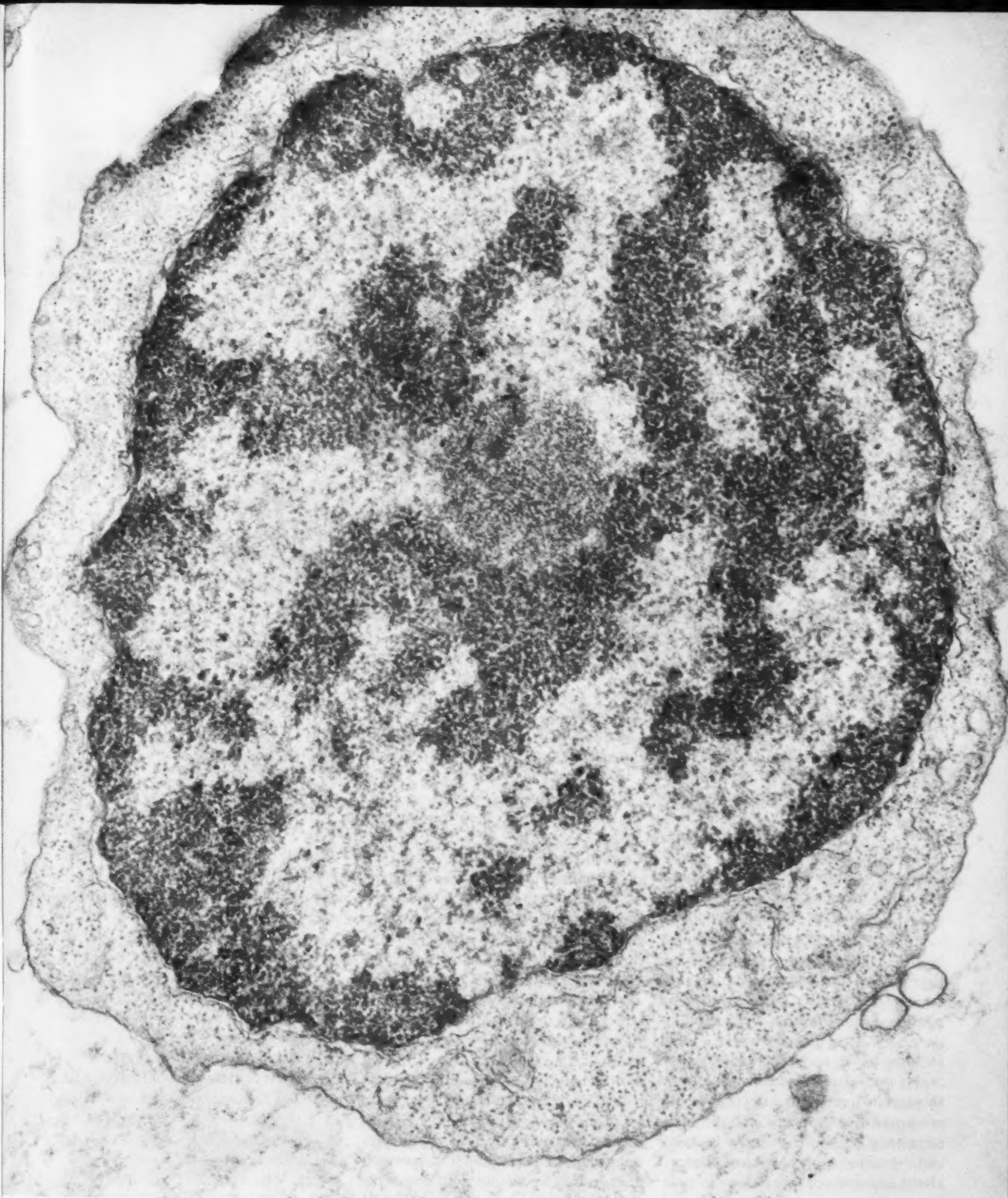


The electron paramagnetic resonance instrument shown here can detect free radicals fed to fish in the form of spin-labels which were chemically attached to contaminants such as hydrocarbons. The information recorded by the instrument can be interpreted to show the manner by which the contaminant affects vulnerable sites within the fish at cellular levels. This new technique, originally developed in health research, is being applied to fisheries for the first time at NWFC.

Our investigation into the effects of contaminants upon fish will involve a three-pronged attack. At a very basic research level, chemists, biochemists, and biophysicists are looking into pathways within the fish or other marine organisms to learn how contaminants move about during different stages in the life history of the organisms. This part of our program involves several new approaches toward investigating effects of changes in environment upon marine organisms.

Biochemical Investigations

Those contaminants soluble in the fat of fish—e.g., chlorinated hydrocarbons like DDT or PCB's and most components of petroleum oil—seem to remain (in the fat) for long periods of time dissolved sometimes in an apparently inert form, sometimes at quite high levels in the parts-per-million range yet often without any obvious harmful effect on the fish. It is possible that it is at the point where there is a heavy drain on fat reserves of the fish that the contaminants, dissolved in the fat, are of most potential harm. A drain on fat reserves occurs at times when fish are not consuming feed, i.e., during winter months when feed may not be available or during spawning periods. During these



Electron micrograph of lymphocyte from peripheral blood of rainbow trout (× 39,500).

Genetic variations and tissue specific activity of the enzyme lactate dehydrogenase (LDH) from three rainbow trout. a) LDH type B'B'; b) LDH type B"B"; c) LDH type B'B". Tissue specific enzyme bands are particularly evident in vitreous fluid and skeletal muscle. Such studies are widely used in determination of genetic variations in fish populations.

periods fish use their own fat as a source of energy and the fat content may decline by one order of magnitude leaving barely enough to satisfy needs for metabolic functions at the subcellular level. Our chemists are examining what happens to contaminants during this rapid fat turnover and they hope to learn precisely how various contaminants adversely affect fish. A better understanding of the nature of what goes on during such damage to fish will offer a shortcut to predicting effects for new contaminants introduced into the environment. With our present lack of understanding as to how contaminants affect marine organisms, each new contaminent must be given time-consuming bioassays requiring weeks or months of work to determine effects on different types of fish, shellfish, etc. With an understanding of the mechanism of what goes on we will be able to set up rapid screening tests to drastically shorten the lengthy research currently required.

Several extremely new, sophisticated laboratory approaches toward getting at such mechanisms are being employed. For example, a new procedure known as spin labeling has been in use in the medical field for only about three years and has never been employed in fishery research. It provides a means for putting a chemical label upon a contaminant so that we cannot only determine how much goes where within the fish as in the older radioisotopic methods but also just how the contaminant is interacting with different vital components of fish at cellular and subcellular levels.

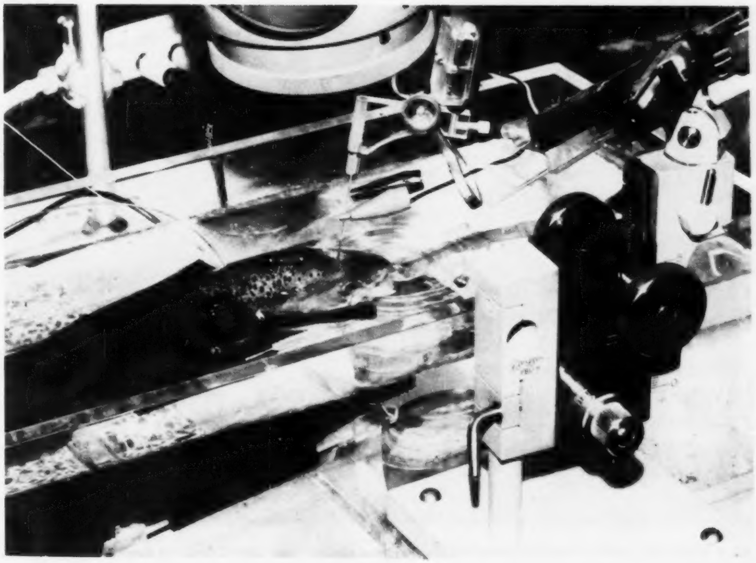
Also included in our program will be an investigation of the mechanism by which fish tie up mercury. Mercury is concentrated by marine organisms in a manner analogous to that by which fish concentrate chlorinated hydrocarbons and similar substances, except that instead of the contaminant ending up in fat depots of the organism it becomes tied up by protein. Very little is known about the mechanism and rate of absorption or release of mercury by fish protein. The work newly initiated in this field will provide answers to problems relative to heavy metals with later work

being extended to other metals such as cadmium and lead.

Laboratory Investigations in Physiology

Physiological studies are aimed at determining the effects of environmental alterations and contaminants on marine and anadromous species. Three principal investigations are under way.

One part of the research is directed towards gaining a better understanding of relationships between man-induced or natural environmental variables and diseases of fish. Any environmental change that enhances the disease-producing ability of a bacterium, for example, or reduces the resistance to infection of a fish species may result in profound effects on population size or even on the survival of that species in the polluted or altered environment. It is well known that temperature is a particularly significant factor in diseases of cold-blooded animals and there is considerable evidence that various chemicals and other stress-inducing factors alter host resistance in warm- and cold-blooded species. Knowledge of environmental conditions contributing to disease is not only important for conserving wild aquatic species, but also is important for species cultivated in aquaculture projects. The latter are held in fixed localities and are, therefore, more susceptible to even temporary periods or local areas of environmental change.



Anesthetized salmon with electrodes implanted for electrophysiologic study of olfaction. NWFC is concentrating on study of the effects of pollutants on olfaction and its role in food-gathering by fish and in homing by salmon.

Analyzing of marine organisms by gas chromatography for amount of hydrocarbons.

Disease-environment interaction studies in progress include: (1) nature and function of disease resistance factors against *Vibrio anguillarum* (an important saltwater fish pathogen) in blood, mucus, and eggs of salmonid fishes; (2) nature and function of fish cells which produce antibody and participate in cellular resistance to infection; and (3) research on effects of certain chemical pollutants on the immune response, on stress, and on disease resistance in salmonid fish.

In a second research area biochemical-genetic studies are in progress which are investigations of the interaction of environmental variables upon genetic characteristics of marine and anadromous species. These studies include: (1) examinations of natural populations and attempts to correlate observed genetic variations with measurable environmental differences; (2) studies on genetically defined types of certain species under controlled laboratory conditions by altering environmental variables such as temperature, levels of contaminants, and salinity and observing the different stocks for physiological changes or mortality; and (3) determination of *in vitro* differences between genetically related enzymes in terms of enzymatic functions and attempting to relate these differences to environmental conditions of living organisms.

A third group of studies relates to effects of environmental changes and contaminants on sensory systems and behavior of fishes. It is known that some sensory receptors, as a result of their role in informing an animal of its immediate exterior environment, are extremely sensitive to pollutants. Present studies are focused on: (1) effects of pollutants on olfaction and its role in food-gathering by fish and in homing by salmon, and (2) lateral line nerve function in salmon and possible disruption by gas bubble disease (which results from fish living in water supersaturated

Work in the laboratory is complemented by investigations in the field. NWFC facilities near the mouth of the Columbia River include this former Coast Guard Station located at Hammond, Oregon.

with air as a result of its passing over dams).

Field Research

The final type of approach to solving problems involving effects of contaminants upon marine organisms is carried out by our field research operations program which conducts practical tests in the natural environment based upon our findings in the laboratory. This part of the research is carried out primarily at three field stations, two on the lower Columbia and one in Puget Sound.

Some of the work of this program has involved monitoring of the level of two chemical components, one that of hydrocarbons from petroleum oil in several species of marine organisms at different parts of Puget Sound. As mentioned earlier such work is important in setting baseline levels for organisms while petroleum oil contamination is still at a very early stage and before any massive oil spills have occurred in Puget Sound. Another small-scale monitoring is under way measuring the level of fluoride along the lower Columbia River. Fluoride occurs in effluents from aluminum plants and if levels increase much above current levels, they may reach a point where damage to fisheries might occur.

Most of the field work currently under way concerns physical effects brought about by industrial or potential industrial operations. One of these concerns certain aspects of gas bubble disease; another, thermal pollution resulting from waters being heated when used for cooling operations in industrial operations, particularly from thermonuclear plants. An important investigation on thermal effects is carried on at our Mukilteo, Washington, field operation on Puget Sound near Everett where the effects of heated water upon crabs, crab larvae, and other marine organisms are under study. Another similar investigation but of more limited scope takes place at Prescott, Oregon, across the Columbia River from Longview, Washington. The effects of contaminants in the Columbia River estuary are investigated from Hammond, Oregon, located on the Columbia River a little over a mile from the mouth of the river. Bioassays on fire retardants used from planes to fight forest fires but which get into streams and rivers and may harm fish are carried out at Prescott.

As the program develops, bioassays carried out in the natural environment of fish will constitute an increasingly important role. The various findings of a biochemical and physiological nature relating to effects of contaminants on the behavior of fish at a laboratory level will be finally checked against what happens in the natural environment carried out on the Columbia River and Puget Sound.

The newly established program brings together highly specialized scientists in diverse fields to investigate effects of contaminants upon fish and other marine organisms. Although we lack vitally needed specialists in such fields as histopathology and toxicology, the Center still has a group of research workers in several scientific fields which we are starting to coordinate to build up a multidisciplinary team which can investigate these problems in a much more efficient manner than in the past. With this well-coordinated approach attacking the problem from different aspects, we expect to make rapid progress toward developing knowledge which will permit in the future a better assessment of threats to our fisheries from changes in the environment and which will point out effective means to cope with the problems as they arise.

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MFR PAPER 979

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Seasonal and Geographic Characteristics of Fishery Resources, California Current Region: IX. Inshore Sportfishes

DAVID KRAMER and PAUL E. SMITH

INTRODUCTION

It has been stated that the sports fishery in California "...is probably the most dynamic of its kind in the world and is currently—not merely *potentially*—yielding some very high returns." (Mathews, 1971). More than one million anglers are estimated to be contributing to that yield each year. Talbot (1969) reported that in 1965 more than two million anglers fished on the Pacific coast spending almost $300 million on this sport. Although there was no breakdown by states, he added, California, because of its population, better weather and species available undoubtedly enjoys a big share of the fishery's effort and catch. The majority of fishermen seldom go beyond the sight of land and many fish only from shores, jetties, and piers.

A subject of recent concern has been at least 12 inshore species of fish for which this great number of anglers are always seeking. The catches of many of these species have been declining by numbers and sizes with only a slight increase in anglers. The fish for which such concern is expressed are: the California halibut, the white sea bass, the halfmoon, the California yellowtail, the ocean whitefish, the California barracuda, the California bonito, the sheephead, the California black sea bass, the California corbina, the spotfin croaker, and the yellowfin croaker (Table 1).

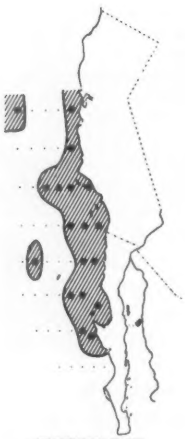
The biological and oceanographic surveys of the California Cooperative Oceanic Fisheries Investigations (Cal COFI) were originally directed toward the eggs and larvae of massive oceanic fish populations like the Pacific sardine (Kramer and Smith, 1971c) and its ecological associates, the northern anchovy (Kramer and Smith, 1971a), the jack mackerel (Kramer and Smith, 1970a), the Pacific mackerel (Kramer and Smith, 1970b), the Pacific hake (Kramer and Smith, 1970b), the rockfishes (Kramer and Smith, 1971b), the Pacific saury (1970b), and the characteristics of their environment, particularly the seasonality of their planktonic food and the water temperature. Unfortunately, the density of stations was not sufficient for the smaller, more dispersed populations characteristic of the sportfishes in general.

As yet, our data on these inshore sport fish species are not sufficient to determine the reasons for the decreases. However, there are enough data to reasonably describe and depict their seasonal and geographic distributions (Table 2, Figure 1a-i) which, combined with future research, may enable us to determine the reasons for the decreases. The distributions are based on

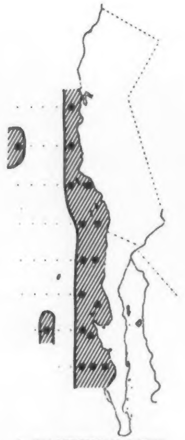
Table 1.—Selected species and/or family groups (see text) of inshore sport fishes in the California Current region.

Family		Species	
Scientific name	Common name	Scientific name	Common name
Sciaenidae	Croakers	*Cynoscion nobilis*	White sea bass[1,2]
		Menticirrhus undulatus	California corbina[2]
		Roncador sternsi	Spotfin croaker[2]
		Umbrina roncador	Yellowfin croaker[2]
		Cheilotrema saturnum	Black croaker
		Genyonemus lineatus	White croaker or kingfish
		Seriphus politus	Queenfish
Serranidae	Basses	*Stereolepis gigas*	Sea bass[2]
		Paralabrax clathratus	Kelp bass
		P. nebulifer	Sand bass
		P. maculatofasciatus	Spotted bass
		Mycteroperca sp.	Groupers
Labridae	Wrasses	*Pimelometopon pulchrum*	Sheephead[2]
		Oxyjulis californica	Señorita
		Halichoeres semicinctus	Rock wrasse
Bothidae	Left-eyed flounders	*Paralichthys californicus*	California halibut[1,2]
Scorpidae	Halfmoon	*Medialuna californiensis*	Halfmoon[1,2]
Carangidae	Jacks	*Seriola dorsalis*	California yellowtail[1,2]
Branchiostegidae	Tilefish or blanquillo	*Caulolatilus princeps*	Ocean whitefish[1,2]
Sphyraenidae	Barracudas	*Sphyraena argentea*	California barracuda[1,2]
Scombridae	Mackerels	*Sarda lineolata*	California bonito[2]

[1]Fish whose larvae have been identified to species. All others are assigned to and grouped within their families with look-alike larvae of species from which they have not been distinguished (see Table 2).
[2]Fish of concern in this report.



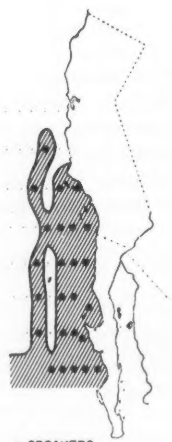
a. WHITE SEA BASS
FEBRUARY



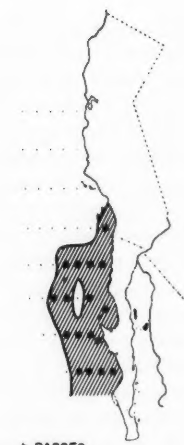
b. CALIFORNIA HALIBUT
FEBRUARY & JULY

c. HALFMOON
JULY

f. CALIFORNIA BARRACUDA
JULY



g. CROAKERS
JANUARY & AUGUST

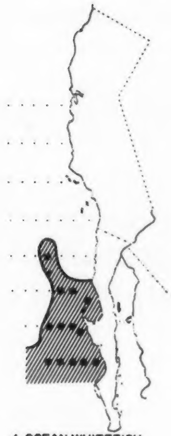


h. BASSES
AUGUST

the enumerations of fish larvae collected in the plankton tows of CalCOFI[1]—each occurrence in any survey conducted from 1955 to 1960 (1956-59 for wrasses and 1956-60 for basses).

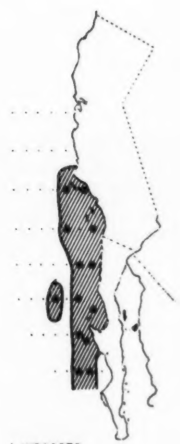
The larvae of six of the species of concern have been identified and enumerated and five have been assigned to their families with their look-alikes of the same or different genera (Table 1). The California bonito is not discussed here because there are so few larvae in our collections—although the commercial catch attests a rather large population. The reasons for their absence in the plankton tows are not known. The six known species are the barracuda, the white sea bass, the halibut, the yellowtail, the ocean whitefish, and the halfmoon. The larvae assigned to and grouped with others in their families are those of the sheephead of the wrasse family (Labridae), which includes the señorita and the rock wrasse—neither one considered a sport fish; the black sea bass of the bass family (Serranidae), which includes the kelp bass, sand bass, spotted bass, and two species of groupers from Baja California (sometimes known from San Diego County)—all considered sport fish; the spotfin croaker, yellowfin croaker, and corbina of the croaker family (Sciaenidae), which includes the black croaker, white

[1]Organizations, area of investigation, and treatment of the data were presented by Kramer and Smith (1970a).



d. OCEAN WHITEFISH
JULY

e. CALIFORNIA YELLOWTAIL
JULY



i. WRASSES
AUGUST

Figure 1a-i.—Regions of spawning of selected species or families of inshore sport fishes in the California Current region 1955-60 (1956-59 for wrasses, 1956-60 for basses). Each circle represents the total number of occurrences in each pooled area (see Kramer and Smith, 1970a). The months designated are those of peak spawning for the fishes depicted (see Table 2 for seasons).

croaker or kingfish, and the queenfish—all considered sport fish. (Note: the white sea bass listed above as one of the known larva species is also a member of the croaker family.)

SEASONAL AND GEOGRAPHIC DISTRIBUTIONS

Seasonal

All of the species except the white sea bass have their peak spawning in July or August. The croakers and the halibut also have peak spawnings in January and February, respectively; white sea bass peaks only in February.

Inshore-offshore

All of the species are inshore and offshore spawners except the halibut and the wrasses, which spawn only inshore.

North-south

Almost all of the species are chiefly southern spawners except halibut and white sea bass, whose spawning ranges extend northward, probably the entire length of California; southward, the halibut spawns the entire length of Baja California, and the white sea bass is delimited to Punta Eugenia. Ocean whitefish and the yellowtail are exclusively southern spawners. The only records we have of yellowtail larvae off southern California are for 1957 (Figure 1e). Part of that year was included in the so-called warm years—mid-1957 through 1959. The halfmoon is delimited from Point Conception, California, to Punta Eugenia, B.C. The barracuda, croakers, and wrasses spawn from Point Conception southward. The basses spawn from San Diego southward.

RESEARCH REQUIRED

NMFS now has the responsibility for the study of all marine fishes and fisheries, recreational and commercial. The management of recreational fisheries will require additional studies of the target species; to better monitor the catch, bigger samples of the landings will be needed. Competition between the sport and commercial fishing industries, the international character of sport fish distributions, and the ill-defined management objectives for recreational fisheries all pose problems to be solved by fishery scientists in the near future.

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Table 2.—Seasonal and geographic spawning of selected species or families (see text) of inshore sport fishes in the California Current region, 1955-60.

Larva species	Spawning months (season)	Peak spawning months[2]	Area of spawning[1]						
			California		Baja California		Geographical delimitation[1]		
			Onshore	Offshore	Onshore	Offshore	Seaward	Northward	Southward
Differentiated									
White sea bass	January-March	February	×	×	×	×	Yes	No	Yes
California halibut	January-April June-September	February and July	×	—	×	—	Yes	No	Yes
Halfmoon	June and July	July	×	×	×	×	Yes	Yes	Yes
Ocean whitefish	June-August	July	—	—	×	×	Yes	Yes	No
California yellowtail	July-August	July	[3]	—	×	×	Yes	Yes	No
California barracuda	June-August	July	×	×	×	×	Yes	Yes	No
Undifferentiated (grouped to families)									
Croakers (including corbina, spotfin croaker, yellowfin croaker)	January-March June-October	January and August	×	×	×	×	Yes	Yes	No
Basses (including giant black sea bass)	July-October	August	×	—	×	×	Yes	Yes	No
Wrasses (including sheephead)	July-October	August	×	—	×	—	Yes	Yes	No

[1]See Figure 1a-i.
[2]Also see Figure 1a-i.
[3]Onshore California only in 1957 (see text).

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MFR PAPER 980

Preliminary Biological Survey of Log-Rafting and Dumping Areas in Southeastern Alaska

ROBERT J. ELLIS

ABSTRACT

A preliminary qualitative study by scuba divers of one raft storage site and four log dumps in marine waters indicated little effect from storage of floating rafts, but fauna and flora adjacent to log dumps were nearly eliminated. The log dumps were characterized by a thick layer of silt, bark, twigs, and other debris which appears to last at least several years. Recommendations for further studies include measurements of physical and chemical changes in the water and substrate, changes in species and abundance of plants and animals, length of time effects of dumps persist, and measurements of changes in biological productivity in the area influenced by the dump.

Most large-scale logging operations in southeastern Alaska store rafts of floating logs in saltwater bays and inlets before towing them to a mill (Figure 1). Logs for these rafts are dumped from trucks that haul the logs to the site from the woods. Some of these sites are used for many years. There has been widespread concern and speculation by fishermen and conservationists that log dumping and long-term log storage in protected bays may be harmful to the marine fauna (especially crabs) that normally inhabit these areas. Some studies of this potential problem have been made in Washington and Oregon, but conditions in Alaska are so different from those farther south that full extrapolation of results would not be warranted. Facts are urgently needed to take the place of speculation concerning the effects of log rafting and dumping on marine fauna. In early June 1970, the NMFS Auke Bay Fisheries Laboratory made a brief study to obtain some of these facts.

The general objective of the study was to familiarize investigators with the physical situation and the fauna involved. This knowledge would then provide a basis for designing a program to determine whether log dumping, rafting, and storage produce significant effects on marine fauna in the vicinity.

METHODS

Underwater observations with scuba were made to observe the amounts of bark, wood, and other debris on the bottom and the numbers of large invertebrates such as crabs, snails, and sea anemones in these areas. Observations were made within study areas and at nearby control areas assumed to be unaffected by logging operations. The data taken consist of a record of subjective impressions of the scuba divers and a report of the plants and animals observed.

The NMFS research vessel *Murre II* was used for transportation from Auke Bay to the study sites and as a base of operations (Figure 2).

Table 1.—Sites visited and number of dives at each during the log-rafting and dumping survey, Peril Strait, June 6-9, 1970.

Site	*Date*	*No. of dives*[1]	*Minutes under water*[2]
Rodman Bay	June 6	1	25
Rodman Bay	June 8	2	50
Appleton Cove	June 6	1	35
Hanus Bay	June 7	2	75
Control Cove	June 7	2	45
Saook Bay	June 8	2	40
False Island	June 6	3	60
False Island	June 8	2	40
Sitkoh Bay	June 9	3	80
Total		18	450

[1]A dive is underwater examination of the area by a team of two divers using scuba. In most instances, each team made extensive examination of shallow-water portions via snorkel diving before each scuba dive.
[2]Time is the sum for teams, not divers.

LOCATIONS OF STUDY SITES

Five sites in North Tongass National Forest in southeastern Alaska that had been used in the past or that are now in use for log dumping or raft storage were studied (Figure 3): Rodman Bay, Appleton Cove, False Island, Hanus Bay, and Saook Bay. In addition, two similar but unused sites were studied as controls: Control Cove in Hanus Bay and Sitkoh Bay. All of the areas are in Peril Strait near Rodman Bay. The sites visited, the number of dives, and the time spent diving at each site are listed in Table 1.

Observations were made in one of each of the following situations: (1) An active log dump and raft-forming site that has been in use for several years (False Island); (2) Three log dumps and raft-forming sites that had been used intensively in the past but have not been

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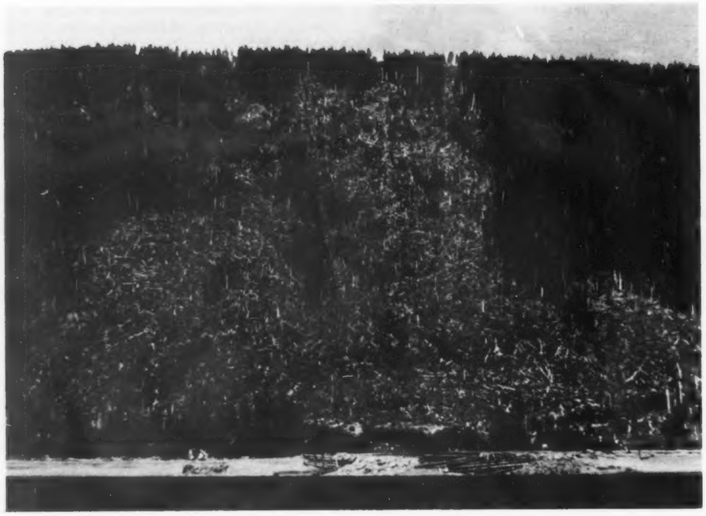

Figure 1.—View of abandoned log dump site at Rodman Bay. The log dump consists of a bulkhead of large logs, backfilled with rock and rubble. The hillside is part of the logged area.

used for at least the last 2 years (Appleton Cove, Saook Bay, Rodman Bay); (3) An active raft storage area (Hanus Bay); (4) Nearby unused areas—for controls or comparison (Control Cove, Sitkoh Bay).

DESCRIPTION OF SITES AND DIVERS' OBSERVATIONS

Rodman Bay Log Dump

Rodman Bay log dump was used from 1961 to 1966 to dump about 160.6 million board feet of spruce and hemlock logs. The littoral area showing effects of the dumping begins at the shore and extends beyond a depth of 75 feet and laterally for about 50 yards each side of the center of the dump much like the delta or outfall of a stream.

Scuba divers saw remnants of the dumping activities on the bottom such as old cables, bundle straps, miscellaneous inorganic debris (e.g. cast iron stove, head gaskets from an engine, and bottles); a few sinkers (logs too heavy to float); and, most significantly, a relatively deep layer of rotting bark, twigs, chips, and silt.

Animals in the area of the dump included sea cucumbers, Dungeness crabs, hermit crabs, sea anemones, shrimps, and clams. The animals were present but markedly less abundant on the outfall of the dump and became more abundant toward the lateral margins of the outfall. The lower limit or greatest depth of the outfall was not determined.

Appleton Cove Log Dump

Appleton Cove dump was used from 1964 to 1968 to dump about 42 million board feet of logs.

The divers found that the entire cove in front of the dump was shallow—no water deeper than 30 feet. Deposits of decomposing debris were observed in scattered depressions. The ocean bottom in front of this dump lacked the extensive deep deposits of woody debris seen at other dumps. No hydrographic reasons for this difference are apparent, and the lack of debris may be simply the result of comparatively fewer logs being dumped here than at other locations such as Rodman Bay. The environment seemed normal except for an accumulation of cables, straps, and other refuse. Only two or three sunken logs were seen, and the few scattered pieces of bark were so rotten that they fell apart when moved.

Animals in the area included three juvenile king crabs, several mature Dungeness crabs, hermit crabs, shrimps, sea cucumbers, sea anemones, clams, and tube worms.

Saook Bay Log Dump

Saook Bay dump was used from 1960 to 1963 to dump about 12 million board feet of logs.

Although this is a relatively small volume of logs, the accumulation of woody debris appeared to the divers to be comparable to Rodman Bay dump rather than Appleton Cove. Decomposing debris was several feet deep, black and foul, and obviously anaerobic. A layer of very flocculent material was easily stirred up at the interface of the deposit and the overlying water. The divers reported a decrease in depth and intensity of the debris with depth down to 50 feet (maximum depth of the dives here).

Animals were very scarce on this soft flocculate bottom but were present on a few sunken logs protruding from the de-

Figure 2.—General view of logged area adjacent to Rodman Bay with *Murre II* in foreground and log rafts beyond.

bris. The thick layer of rotting organic material was confined to a narrow strip along shore immediately in front of the dump. Normal kinds and numbers of animals were present in the areas adjacent to the dump.

False Island Log Dump

False Island log dump is being used now and has been used since 1966. About 102 million board feet of logs had been dumped to May 1970.

The area in front of the dump was covered down to a depth of 75 feet and beyond with a layer of wood and bark debris, needles, twigs, sand, gravel, and steel bands. Here the surface layer consisted of loose, newly deposited material with no signs of decomposition. Visibility was very poor because of the dark color of the water and much suspended fibrous material.

Very few animals were seen on the loose debris but some were present on the few rocks projecting through the debris. Animals on the rocks included serpulid worms, rock jingles, limpets, chitins, and a small cottid fish. A few sea cucumbers and starfish were on and in the loose debris immediately in front of the dump. Present along the margin of the thick debris were a few *Mya truncata* (a soft shell clam), burrowing sea cucumbers *(Cucumaria?)*, and one juvenile king crab.

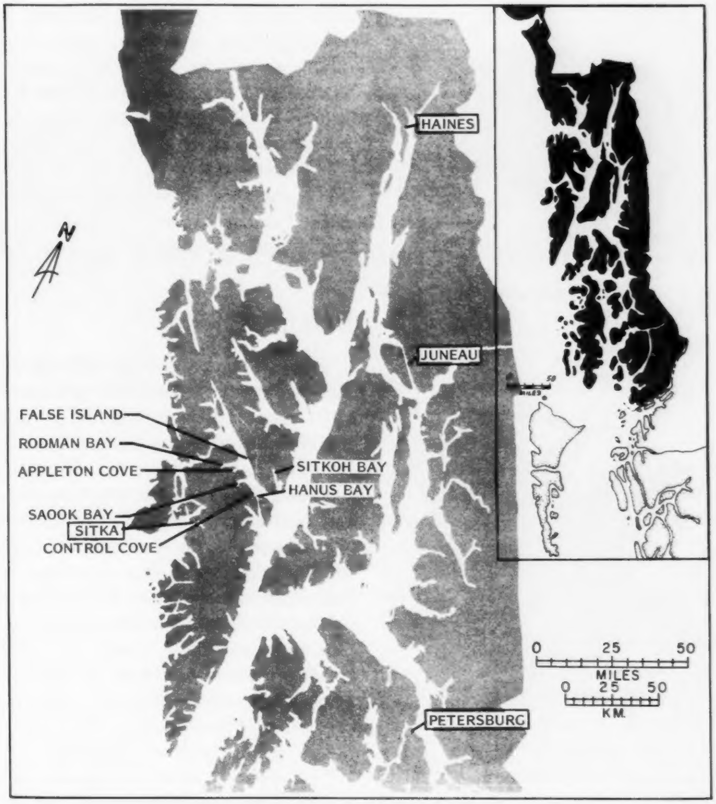

Figure 3.—Locations of study sites.

Hanus Bay Log Raft Storage Area

Hanus Bay has been used for storage of floating log rafts since 1963. It has an annual turnover of about 30 to 45 rafts (or 10 to 15 million board feet). No logs have been dumped in Hanus Bay, but a future dump is planned for the northeast corner of the bay.

Two dives were made along and under the rafts—one group of divers went toward the head end of the bay (southwest) and the other group toward the outlet (northeast). In general, conditions in the vicinity of the log rafts appeared to be similar to adjacent areas. All of the bottom in Hanus Bay was covered with a layer of silt, which may be a normal condition because it was seen later at Control Cove and Sitkoh Bay where no dumping or rafting has occurred.

Plants (kelp and smaller algae) and animals were abundant. The only apparent effect of the rafts was a marked decrease in abundance of plants directly under the rafts—possibly the result of shading. Animals observed included many shrimp, horse crabs, sea cucumbers, hermit crabs, sea anemones, sand lance, blennies, and cottids. Only a few adult Dungeness crabs were seen close to the raft, but closer to the stream at the head of the bay, many female Dungeness crabs were seen. Several yellowfin sole were caught by hook and line fishing.

Control Cove

Control Cove is the first cove inside Point Moses and was selected as an example of a local area with no history of logging activity.

Two dives were made in Control Cove—one from the head of the bay down to about 50 feet and the other farther out where the bottom was about 100 feet deep. The deeper dive covered the bottom from shore to 100 feet and up the other side to about 30 feet. The bottom was of rock, gravel, sand, and shell. No accumulations of wood debris were seen.

Plants and animals were abundant in Control Cove. Animals observed included juvenile king crabs, pink scallops *(Chlamys)*, sea cucumbers, many hermit crabs, shrimps, and sea anemones. No Dungeness crabs were seen.

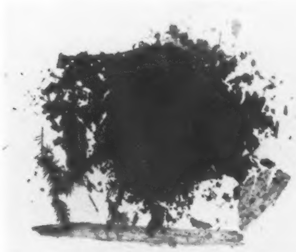

Figure 4.—Debris from False Island log dump, collected June 8, 1970.

Figure 5.—Debris from Saook Bay log dump, collected June 8, 1970.

Sitkoh Bay

Sitkoh Bay has had no logging activity but is scheduled to be the site of a log dump and rafting area.

We made three dives in the vicinity of the proposed site of the dump and booming grounds immediately adjacent to the delta of Sitkoh River. The bottom was rock or firm gravel and sand to a depth of 100 feet in the vicinity of the delta. The bottom was softer below about 70 feet in depth in areas away from the delta.

Plants and animals were abundant in this area. The shallower areas (down to about 30 feet) were covered with a heavy growth of broad-leaved kelp. In this zone we saw many adult male Dungeness crabs, horse crabs, and sea cucumbers. Immature and female king crabs were seen in deeper water. Sea anemones, hermit crabs, and shrimps were abundant in most of the area. Hook and line fishing in 90 feet yielded halibut and sole. The stomach of one of the halibut contained five juvenile tanner crabs.

DISCUSSION

The outstanding feature noted in our surveys was the tremendous but apparently localized accumulation of bark and wood debris at log dumps. This debris eliminates the plants and nearly eliminates animals from the area. How long this debris will persist is unknown. Photographs of the bark and wood debris from the Saook Bay and False Island log dumps (Figures 4 and 5) show the nature of the material. Spruce needles and soft black mud are recognizable in the sample from Saook Bay. Hemlock needles, bark, and chips are recognizable in the sample from False Island, but no mud was present.

The apparent lack of residual debris at the Appleton Cove dump and the inordinately large amount of debris at Saook Cove raise questions as to the relative "dirtiness" of different logging and dumping techniques. The dumping method at False Island entails banding the logs on the truck and lifting them up and lowering them nearly to the water before dropping the bundle. Although this technique would be expected to dislodge a minimum of bark and wood, debris is still very abundant on the bottom.

Clearly, the dumping of bundles of logs into the water changes the normal marine environment of the immediate area. The extent, persistence, and significance of the changes remain to be determined.

Observations of the vicinity of the Hanus Bay raft storage area indicated little or no abnormal appearance in littoral plants and animals; however, there was a marked decrease in abundance of plants directly under the rafts.

RECOMMENDATION FOR FURTHER STUDY

The apparent damage caused by dumps, the probability of a great proliferation of log-dumping sites, and the alternative possibility of utilizing a dry storage and barging technique for getting logs to the mill combine to make further study of the effects of log dumps on the littoral ecology imperative. The proposed Sitkoh Bay log dump and booming site is in a highly productive littoral area, and this site could be the subject of a serious attempt at answering several important questions: (1) What are the chemical and physical changes in the water and substrate accompanying the establishment and use of the log dump? (2) What is the extent of the area affected by the log dump? (3) What kinds and how many plants and animals are removed from the dump site? (4) How long do the effects of the dump remain? (5) Does the biological productivity of the area around a dump increase and compensate in any way for the loss at the site itself?

ACKNOWLEDGMENTS

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The following divers participated in this survey: Robert Ellis, Project Leader; Robert Dewey, Biologist; John Helle, Biologist; David Hoopes, Biologist; Louis Barr, Biologist; Setsuwo Tsunoda, Biologist; Richard Williamson, Biologist; and Robert Budke, Technician.

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The coming decade will be one of increased competition and search for new sources of supply.

The U.S. Shrimp Industry: Past Trends and Prospects for the 1970's

DONALD R. WHITAKER

ABSTRACT

The U.S. shrimp industry has expanded rapidly during the last two decades and is expected to continue growing during the 1970's. Production has grown in recent years because of rapidly increasing catches of northern shrimp. Total production likely will continue upward, but not as rapidly as in recent years. Most, if not all, of the increase will come from northern shrimp landings. Per capita consumption of shrimp has doubled. Total consumption of shrimp is expected to expand during the 1970's but whether it will expand at a faster rate than the population will depend on discoveries of new resources around the world. Demand for quality and demand for increased services are expected to rise.

INTRODUCTION

The shrimp industry, an important segment of the Nation's fisheries economy, has undergone significant changes during the last two decades. The industry has been characterized by such developments as new areas of production and new processed products, improved technology in producing and processing, shifts in consumer demand, better facilities for storage, and improved packaging. These changes reflect the nature of the type of demand facing the shrimp industry and the changing structure of markets.

This report is a general review of developments in the U.S. shrimp industry over the last two decades and its prospects for the 1970's.

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TRENDS AND DEVELOPMENTS

Geographic Shifts in Production

Nearly every coastal state is a commercial producer of shrimp, but significant production is concentrated in a relatively few states. The bulk of the production comes from the Gulf States; production of northern shrimp is distributed on both the east and west coasts.

Although fluctuations occur in shrimp production from year to year, the overall trend has been upward (Figure 1). Total production of the domestic fleet increased from an annual average of 135.1 million pounds, heads-off weight, in 1950-52 to 189.7 million pounds in 1967-69. Output of southern shrimp rose from 132.8 million pounds, heads-off, to 147.0 million pounds. Northern shrimp production showed a remarkable increase from 2.2 million pounds, heads-off, to 42.7 million pounds.

While total domestic shrimp production has generally trended upward, especially in recent years, there have been shifts in the relative importance of producing areas. The South Atlantic States' share of the total production has declined since 1950 (Table 1), whereas the Pacific States, including Alaska, gained from 1.2 percent of total production in 1950-52 to 13.5 percent in 1967-69. Production in New England also rose sharply from less than 0.1 percent in the early 1950's to 5.0 percent in 1967-69. The overall upward trend in shrimp production has come about primarily because of increases in landings of northern shrimp. Consequently, southern shrimp dropped from 98.4 percent of the total in the early 1950's to 77.5 percent at the close of the 1960's.

As the 1960's came to a close, some major shifts in production were in the making. Between 1964 and 1969, shrimp production in New England doubled each year and reached a peak of 16.6 million pounds, heads-off, in 1969. The 1969 New England catch was probably near the maximum sustainable yield for the region. Pacific Coast production has also grown rapidly, especially during the last half of the 1960's. Alaska ac-

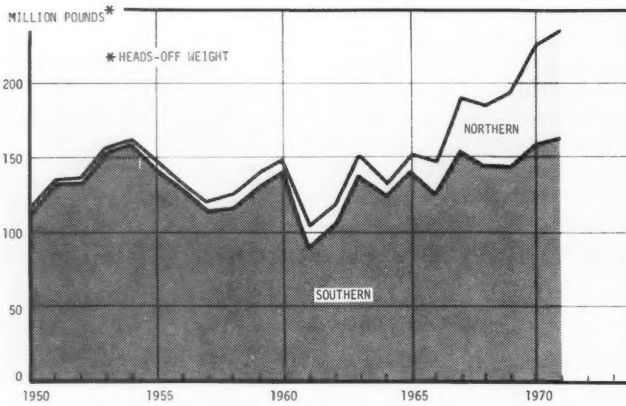


Figure 1.—U.S. shrimp landings, 1950-71.

counts for most of the shrimp landed in the region. Large untapped resources have been exploited, and the potential exists for further increases in production.

Imports Become An Important Source of Supply

After World War II, shrimp imports increased rapidly—from 8 million pounds in 1945 to 40 million pounds in 1950; however, this was only the beginning of a worldwide search for shrimp supplies which continues even today. In 1950, most imports came from other North American countries, principally Mexico (Table 2). By the late 1960's, only half of the shrimp imports were coming from North America while 29 percent were coming from Asia, 19 percent from South America, and small quantities from the rest of the world. Over the years, Mexico has been the largest supplier to the United States. Imports from Mexico reached a peak of 79.2 million pounds in 1961 and trended downward for the remainder of the 1960's; however, Mexico continued to lead all other countries. India exported only small quantities in the 1950's, but exports from there rose sharply in 1960's so that India became the number two foreign supplier to the United States. Panama consistently shipped large quantities throughout the 1960's and ranked third among all countries.

The general picture over the past two decades is one of rapid expansion in imports—8.8 percent per year (Figure 2). Since 1960, imports from North America have generally stabilized, indicating no discoveries of additional large shrimp producing areas.

When imports from North America began to stabilize, imports from South America increased rapidly from 11.8 million pounds in 1960 to 47.4 million pounds in 1970. Imports from Asia increased from 8.6 million pounds in 1960 to 57.8 million pounds in 1970; India has been the leading source, with Pakistan second and the Persian Gulf area third in importance.

Changes in Production Technology

The U.S. shrimp industry has tended to purchase large, more seaworthy vessels that enable it to range farther from home port. In the past, shrimp were caught primarily in shallow coastal waters. Now shrimp vessels move throughout Gulf of Mexico, Caribbean,

Table 1.—Changes in the absolute and relative importance of individual shrimp producing states, 1950-52, 1967-69, and 1971.

	PRODUCTION			SHARE OF TOTAL PRODUCTION		
State and Area	1950-52 average	1967-69 average	1971	1950-52 average	1967-69 average	1971
	1,000 lbs., heads-off wt.			Percent		
NEW ENGLAND						
Maine	30	8,650	9,864	[1]	4.6	4.2
Massachusetts	2	769	3,403	[1]	.4	1.5
New Hampshire	—	46	68	—	[1]	[1]
TOTAL	32	9,532	13,335	[1]	5.0	5.7
SOUTH ATLANTIC						
North Carolina	5,289	3,469	4,740	3.9	1.8	2.0
South Carolina	3,260	3,378	6,904	2.4	1.8	2.9
Georgia	5,191	4,992	5,722	3.9	2.6	2.4
Florida (East coast)	5,115	3,125	2,188	3.8	1.7	1.0
TOTAL	18,855	14,964	19,554	14.0	7.9	8.3
GULF						
Florida (West coast)	16,884	15,372	13,515	12.5	8.1	5.7
Alabama	3,684	9,359	10,459	2.8	4.9	4.4
Mississippi	9,591	5,980	5,909	7.0	3.2	2.5
Louisiana	47,101	47,673	58,630	34.9	25.1	25.0
Texas	36,730	53,654	54,372	27.2	28.3	23.1
TOTAL	113,990	132,038	142,885	84.4	69.6	60.7
PACIFIC						
California	564	1,183	1,226	.4	.6	.5
Oregon	—	5,941	3,707	—	3.1	1.6
Washington	34	656	422	—	.3	.2
Alaska	1,615	25,364	54,111	1.2	13.5	23.0
TOTAL	2,213	33,154	59,466	1.6	17.5	25.3
GRAND TOTAL	135,090	189,688	235,240	100.0	100.0	100.0

[1]Less than 1/10 of 1 percent.

and northern South American waters. The shrimp fishery in New England and the Pacific States is conducted in nearby coastal waters.

The number of shrimp vessels and boats increased from 7,193 in 1950 to nearly 12,000 in 1970. This increase in fishing craft has been fairly steady over time. The number of vessels (5 tons or over) reached a peak of 4,773 in 1970. The gross tonnage of all vessels is a better indicator of trends in the fleet than number of actual vessels. Even though the number of vessels rose only slightly in the 1960's, the total gross tonnage increased from 142,000 tons in 1960 to 238,000 in 1970. So the capacity of the fleet has grown because of increasingly larger vessels. The overall increase in craft and fishermen has caused only a slight increase in southern shrimp landings. The number of shrimp fishermen increased from 15,600 in 1950 to 23,000 in 1970.

Table 2.—Changes in the absolute and relative importance of individual countries exporting shrimp to the United States, 1950-52, 1967-69, and 1971.

COUNTRY	IMPORTS			SHARE OF TOTAL IMPORTS		
	1950-52 average	1967-69 average	1971	1950-52 average	1967-69 average	1971
	— — Million Pounds — —			— — — Percent — — —		
Mexico	37.7	62.1	74.6	93.8	32.8	39.0
India	[1]	24.9	22.8	—	13.1	11.9
Venezuela	[1]	5.4	10.1	—	2.8	5.3
Panama	1.8	10.6	9.3	4.5	5.6	4.9
Guyana	—	8.4	9.0	—	4.4	4.7
El Salvador	—	5.4	6.7	—	2.8	3.5
Nicaragua	—	5.9	5.6	—	3.1	2.9
Ecuador	[1]	7.1	5.3	—	3.7	2.8
Colombia	[1]	3.1	4.8	—	1.6	2.5
Brazil	—	1.8	4.4	—	.9	2.3
French Guiana	—	6.8	3.8	—	3.6	2.0
Honduras	—	2.9	3.9	—	1.5	2.0
Trinidad	—	2.5	2.4	—	1.3	1.3
Guatemala	—	1.6	2.3	—	.8	1.2
Costa Rica	[1]	1.8	2.3	—	.9	1.2
Australia	[1]	1.1	2.7	—	.6	1.4
Kuwait	—	6.5	2.2	—	3.4	1.1
Surinam	—	2.7	2.1	—	1.4	1.0
Thailand	—	2.7	2.0	—	1.4	1.0
Barbados	—	2.1	—	—	1.1	—
Other	.7	24.2	15.0	1.7	13.2	8.0
TOTAL	40.2	189.6	191.3	100.0	100.0	100.0

[1]Less than 50,000 pounds.

Shifts in Utilization

A striking shift in utilization of shrimp has occurred over the last 20 years. With the increased demand for convenience foods, processed shrimp has provided a larger outlet for those producing shrimp, as the convenience aspects appeal to the more affluent buyers. At the same time the fresh market has declined in importance.

Trends in Consumption

Past utilization trends provide the basis for examining the changing pattern of shrimp consumption. Changes in consumption patterns generally reflect the interaction of various factors such as supply, price, income, population, demand, and consumer preference and tastes.

Total consumption of shrimp in all product forms has risen spectacularly. Annual shrimp consumption rose from 140 million pounds, heads-off, in 1950 to 412 million pounds in 1970—increasing at an average of 13.6 million pounds per year (Figure 3). Since 1970, consumption has averaged over 1 million pounds per day.

Shrimp consumption advanced more rapidly than the growth in population; consequently, per capita consumption doubled in the past two decades. Per capita consumption rose from 0.92 pounds, heads-off weight, in 1950 to 2.02 pounds in 1970.

Most of the increase in shrimp consumption has been in frozen shrimp. Growth in fresh and frozen shrimp consumption compared with the growth in consumption of canned shrimp is indicated in the following table:[1]

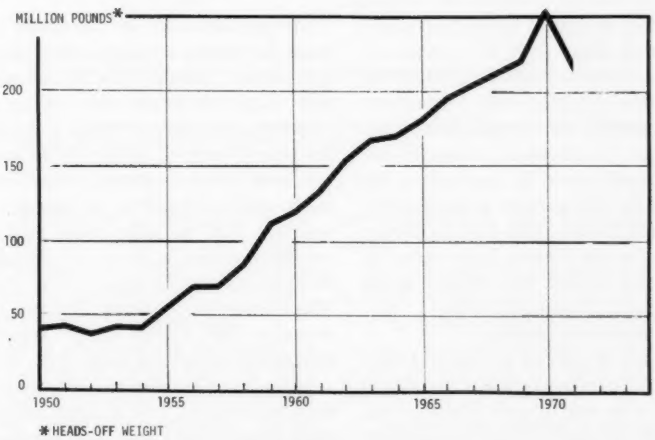


Figure 2.—U.S. shrimp imports, 1950-71.

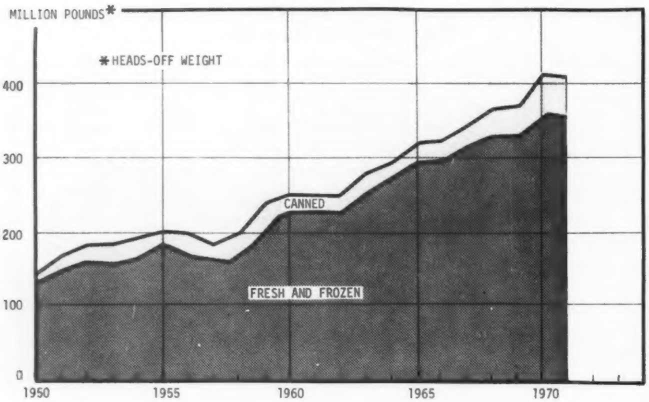


Figure 3.—U.S. shrimp consumption, 1950-71.

Year	Fresh and Frozen	Canned
	Million pounds, heads-off	
1950	118	22
1955	179	22
1960	228	24
1965	290	24
1970	357	56

[1]Consumption of fresh shrimp has been declining, but actual figures are not available.

Consumption of canned shrimp rose only slightly from 1950 to 1967. However, between 1967 and 1970, canned shrimp consumption doubled. Canned northern shrimp accounted for most of the increase in recent years.

Shrimp consumption in the United States has increased faster than world production. Since 1955, U.S. consumption has increased 82 percent, but world production has risen only 58 percent. Consequently, the United States has consumed an increasing share of the world catch—from 26 percent in the mid-1950's to 34 percent at present. By consuming a third of the world's shrimp production, the United States is by far the largest market for shrimp. Japan ranks second, consuming about 15 percent of world production.

Changes in shrimp products during the last 20 years can be traced to several factors. The substitution of processed for fresh shrimp is closely associated with changes in consumer tastes and preferences, living patterns which include more working wives and convenience in shopping. Processed shrimp are essentially convenient and timesaving foods. As family income rose, consumers were willing to pay higher prices if necessary to obtain such "built-in" services.

Development of new or modified product forms, improved quality in processed products, and year-round availability have also contributed greatly to the increase in consumption of processed shrimp.

Prices Increase

Strong advances in consumer demand for shrimp products, especially in the sixties, boosted prices considerably. Long-run trends show prices advancing at the rate of about 6 percent per year (Figure 4). Although the trend has been upward, shrimp prices have been quite responsive to changes in supplies. For example, prices paid for southern shrimp at dockside averaged 36 cents per pound heads-off in 1950. The average price rose to 83 cents per pound in 1969. Larger market supplies caused a drop to 76 cents in 1970. Short supplies in 1971, due to a big drop in imports, resulted in an average price at dockside of 97 cents for southern shrimp.

Besides the overall increase in shrimp prices, other interesting trends are evident in dockside prices for southern shrimp. The larger the shrimp, the greater has been the rate of increase in price. Prices of small southern shrimp, 70 count and more, have increased little in the past decade. Medium shrimp have risen by 4 to 5 percent per year while larger shrimp have increased 7 to 8 percent per year. This means that the spread in price between the smallest and largest shrimp has widened considerably (Figure 5). A decade ago, a fairly constant margin of 4 to 5 cents was quoted between each size of southern shrimp. By the late 1960's, these relatively constant margins no longer existed. Price spreads between the various sizes ranged from 5 cents to 25 cents or even more. Consequently, buyers began to shift purchases to smaller sizes more often than before. For example, if a restaurant found the price of 21-25 count shrimp too costly, it simply bought 26-30 shrimp at a lower price rather than cut down on the size of a serving or reduce the number of shrimp in a cocktail.

Because of the small size of northern shrimp, fishermen normally receive one price for their entire catch. While southern shrimp fishermen received 97 cents per pound for their catch in 1971, northern shrimp fishermen received 8 cents per pound. Several reasons exist for this apparently large discrepancy in shrimp prices. Because of their size, northern shrimp are not headed on board vessels as southern shrimp are. Also the edible meat yield from a northern shrimp is considerably less than from a southern shrimp. Probably the major reason for the difference in price to date is the taste and preference of consumers. The majority of American consumers are familiar with the larger southern shrimp, which has a different taste and texture.

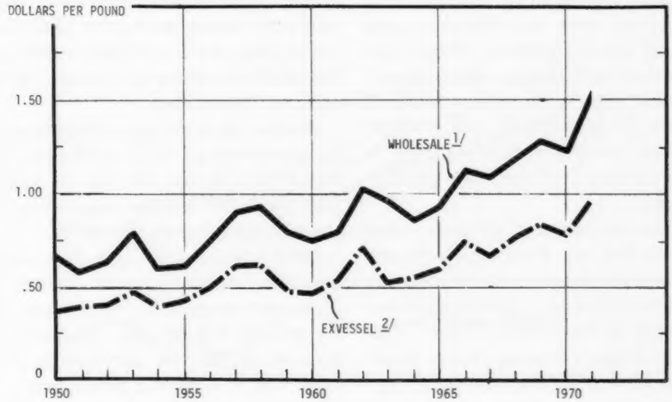
Exports

Exports of U.S. shrimp products began a strong upsurge in the early 1960's that, except for a few short downturns, continues at present. This provided an

outlet for nearly a fifth of domestic catches in recent years.

Overseas sales of frozen shrimp ranged between 1 and 2 million pounds in the 1950's. They increased from 3 million pounds in 1960 to 30 million pounds in 1970. Foreign markets for frozen southern shrimp developed slowly, reaching 8 million pounds in 1967. The jump in exports of frozen shrimp to 12 million pounds in 1968, 25 million pounds in 1969, and 30 million pounds in 1970 was primarily the result of opening new markets for northern shrimp in Western Europe and Scandinavia. Exports of canned shrimp expand gradually from 2.2 million pounds, heads-off weight, in 1950 to 11.2 million pounds in 1970.

In the 1960's exports also increased because of transshipments of foreign shrimp through the United States. Japan relaxed import controls on shrimp in 1961 in order to meet the growing demand for shrimp in that country. One of Japan's principal suppliers has been Mexico. Because of a lack of port facilities on the West Coast of Mexico, much of the production from that area destined for Japan is transshipped through California to Japan. Transshipments reached a peak of 15.9 million pounds in 1967; in 1970 they were 14.7 million pounds.



1/ Gulf of Mexico brown shrimp, raw headless, 26-30 count, at Chicago

2/ Weighted average price for all sizes and species landed in South Atlantic and Gulf states

Figure 4.—Annual prices for southern shrimp, 1950-71.

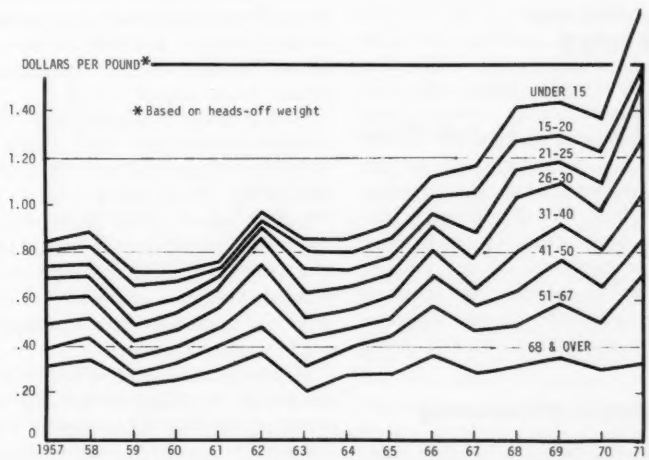


Figure 5.—Annual ex-vessel prices for southern shrimp, 1957-71. Small shrimp (68 count and over) have increased little in price; large shrimp (under 15 count) have increased greatly.

Changes in Marketing and Processing Industry

As a result of the changes in supply and demand many adjustments have taken place in marketing and processing of shrimp.

The growth of supermarkets with their emphasis on merchandising of uniform quality products plus expanded geographic production and improved transportation have resulted in a shift to direct marketing of shrimp. The old marketing system from fisherman through local buyer to wholesale market and retailer is less prevalent. Many fishermen deliver to shipping points which have also become the assemblers and first handlers.

As a result of increases in direct purchases by institutions and retailers at major shipping points, the volume handled by wholesalers has probably been growing only moderately.

Shifts in consumption from fresh to processed frozen shrimp have been also associated with changes in marketing of shrimp for processing use. As an increasing proportion is processed, processors want the fishermen to maintain quality and insure a dependable supply.

Here the growing use of imports has helped in eliminating some of the seasonality in shrimp processing. Also, the use of contracts between overseas producers and domestic processors has become more important.

Changes in the marketing system and equipment have brought changes in the transportation of shrimp. An increasing

portion of shrimp moves to market by truck rather than rail. The increased share of truck shipment reflects improvements in highways and increases in truck size with well-equipped mechanical refrigeration units. Truck shipments are particularly adapted to receive shrimp from the many producing areas.

Increased demand for processed shrimp is not only having a significant impact on the structure of shrimp marketing, but there also have been many changes in the processing industry. The number of plants freezing shrimp products has increased. The number of canning plants decreased from 50 in 1950 to 37 in 1970, but the volume processed increased.

PROSPECTIVE DEVELOPMENTS IN THE 1970'S

With the preceding review of trends in supplies, utilization, consumption, and marketing as background, further changes can be anticipated for the 1970's. Prospects for the shrimp industry, like those for other fisheries, depend on many factors—not only those peculiar to the shrimp industry, but also those affecting consumer incomes and preferences and the supplies and relative costs of closely competing products.

Harvesting and Processing

Increased efficiency together with continued increases in use of capital will contribute to more specialization in shrimp harvesting and processing. Many small and marginal vessels and plants may be forced to become more efficient or go out of business. Growth in the total number of shrimp vessels is likely to slow somewhat from the heavy rate of construction in the late 1960's and early 1970's. The number of plants with larger sales will increase. Relatively high costs for labor will lead to continuing substitution of mechanization.

Domestic shrimp landings may increase slightly from current levels. Southern shrimp production likely will not increase much more than at present. But northern shrimp production can be expected to increase.

Production of shrimp will continue to be concentrated in a relatively few states. Alaska may become the dominant producer—further increasing its share of the domestic catch.

Shrimp aquaculture is being carried out experimentally by a number of firms, but progress has been slow. By the end of the decade, commercial aquaculture may be contributing in a small way to domestic production.

Increased demand for processed shrimp has stimulated the processing industry to improve plants and equipment. Some small processors will either discontinue operations or merge with larger, more efficient operating units. More efficient processing, development of new products, and improvements in product quality will contribute to expanded processing of shrimp.

More overseas processing may occur as countries try to earn more dollars by shipping finished products rather than raw shrimp. This trend has been very evident in imports of raw peeled shrimp which more than doubled between 1964 and 1970. At present, imports of breaded shrimp are practically nil, and imports of canned shrimp are small relative to domestic production.

In the decade ahead, it seems that processing of shrimp by freezing will continue to grow more rapidly than canning. Drying will continue to decline in relative importance.

Demand

A rising standard of living, increased employment of women, and the desire for more leisure time will contribute to the growing demand for convenience foods. Processed shrimp with their reduced perishability, standardization, and longer shelf life provide the housewife with a year-round choice of shrimp products.

Total demand for shrimp will increase in the years ahead due mainly to the population growth and continued increase in personal disposable income. Per capita shrimp consumption is expected to increase during the 1970's but probably not as fast as in the past two decades. Shifts in consumer preference from fresh to processed shrimp will continue.

Imports

The expected increase in consumption during the 1970's will be possible only if imports of shrimp continue upward.

In the 1960's imports from other North American countries tended to level off after the rapid growth of the 1950's. Imports from North America have been about 90 to 100 million pounds in the last 10 years. This would seem to indicate that all major producing areas in other North American countries have been exploited. The year-to-year changes in imports probably now reflect changing abundance in these countries. Another increase in the 1970's does not appear likely.

Asian shrimp resources are being rapidly developed. Imports from that area likely will comprise a greater part of our total imports in the 1970's. Imports from Africa likely will increase also.

World Competition for Shrimp

The domestic industry will continue to face keen competition from foreign sources for available shrimp supplies. Further increases in imports are likely. However, their rate of growth may not be as fast as experienced during the past two decades. Estimates of the maximum sustainable yields (MSY) for the many species of shrimp around the world total 1,487,000 metric tons (Fullenbaum, 1970). In 1970 the world catch of shrimp was 930,000 tons (FAO, 1971). As of two years ago, the catch was at 63 percent of the estimated MSY; it is probably near 70 percent at present. For the past two decades, world shrimp catches have been increasing at an average annual rate of about 5 percent (Figure 6).

If this rate continued during the decade of the 1970's, shrimp catches would be at the estimated MSY by 1980.

Two forces are expected to be at work which will tend to slow down the rate of increase in our imports and at the same time tend to push world prices upward. First, as production nears MSY, the discovery of new resources becomes more costly. Shrimp resources of a marginal nature will come into production, but only if prices increase enough to make operations profitable. In other words, the cost of catching the last 10 percent will be greater than the first 10 percent of a virgin stock. Second, world competition for available shrimp supplies is likely to increase, driving prices up even further. The competition is expected to come from Japan and Western Europe.

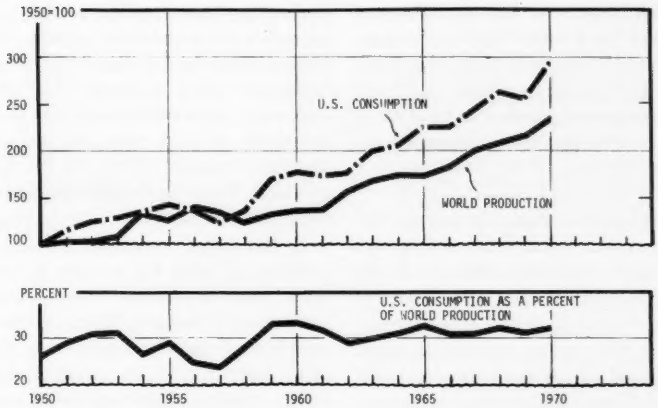


Figure 6.—During the past two decades, world production of shrimp has been increasing at an annual average rate of about 5 percent (upper panel). U.S. consumption has been increasing more rapidly, reaching (lower panel) about one-third of world production in the past few years.

Japan has been a factor in the world shrimp market since the early 1960's when import restrictions on shrimp were lifted. Japan generally paid a premium price, but her purchases were only a small part of total world production. Demand has increased so sharply that Japan, like the United States, now imports more shrimp than she produces domestically. In the mid-1960's Japan began an aggressive program of joint ventures in several shrimp producing nations. There investments are now producing an increasing flow of shrimp to Japan.

In 1973 a new government agency in Japan is expected to be created to help industry continue its expansion in fisheries around the world. As the 1970's began, competition with Japan for shrimp supplies was quite noticeable, and it is expected to continue keen in the years to come.

Although the United States and Japan consume half of the world shrimp catch, shrimp exporting nations have a third large market available—the Common Market countries of Western Europe. The Common Market has a combined population a little larger than that of the United States. The combined economies of these countries are equivalent to about 80 percent of the U.S. economy. Thus, the Common Market will be a strong competitor of the United States.

Marketing

With retail chains getting larger, more shrimp likely will be purchased directly. Large institutional buyers will also tend to buy directly. However, wholesalers with a decreasing share of the market will continue to exist as outlets for specialty items, and likely will offer a wider range of services.

Prices

Even though supplies of shrimp may moderately outrun gains in population over the decade, rapid advances in consumer demand point to continued favorable dockside prices, especially in the southern fishery. Prices for processed shrimp products have been increasing at a rate of 6 percent per year for the past decade. Assuming a continued strong demand, this trend likely will continue and possibly at an even higher rate.

Exports

The volume of U.S. shrimp exports likely will continue to expand in the 1970's. This increase assumes a growing world demand and a continuation of present trends in world shrimp output. Biggest gains in volume are likely for frozen northern shrimp. Only slight increases appear likely for frozen southern shrimp, while exports of canned shrimp may change little.

Distributing Shrimp Output

Fishermen, processors, and distributors in recent years have tended to work more closely together to reduce some of the uncertainties in supplies which characterize the shrimp industry. Trends have been toward contracting catches both here and abroad. Processors have merged with large national food concerns. The more efficient production-marketing system that is slowly evolving will contribute to steadier earning flows for fishermen and marketers in the shrimp business system.

CONCLUDING COMMENTS

Substantial improvement in economic performance of the shrimp industry during the past two decades is clearly evident. Total output of product and services by the industry has risen almost steadily. Recognition has been given to shifting and varying preferences of consumers. Progress has been made in the development and adoption of advanced technology.

Improvements in pricing efficiency also have been made. Marketing information programs have been expanded, all levels of industry are better and more equally informed, grade standards are in more general use, and communication among segments of the industry takes place more quickly and accurately.

Developments abroad in foreign supply areas and markets for shrimp will have more profound effects on the shrimp industry in the United States in the future than they had in the past.

Even with strong demand at home and abroad for shrimp produced in the United States, competitive pressures, developed through cost-reducing innovations, likely will increase and intensify. Prices will tend to reflect costs of more efficient operators. The more progressive processors probably will be taking advantage of all available opportunities for reducing procurement, plant, and distribution costs, and, as a result vertical integration and merger may become more prominent features.

There are three ways in which the shrimp business can grow. One is in response to population growth, i.e., more consumers. A second is through higher per capita consumption. A third, and very promising potential, is the provision of extra services and convenience features along with the basic product. There is virtually no limit to these latter possibilities.

In the future, processors would do well not to stick too closely to traditional lines of products and marketing structures. Changing living habits of people and greater mobility and affluence have markedly changed food habits creating opportunities in snack foods, barbecue, catering, franchised outlets, and drive-ins, plus new foods for the kitchen which require a minimum of preparation. The successful shrimp processor of the future will be highly market-oriented and constantly innovating.

A continuing future challenge for the shrimp industry is in the development of foreign markets, particularly for northern shrimp. Price and consistency of supply are main limiting factors in shrimp trade expansion. U.S. shrimp prices are probably high relative to most shrimp-surplus-exporting countries. A dependable export business cannot be built on uncertain, fluctuating supplies.

For continued survival, more effective progress through early adjustment to change and achievement and maintenance of relatively high levels of efficiency will be required. In general, however, the future offers challenging opportunities for the industry and for the individual or firm with foresight to see the possibilities, with the ability to plan carefully and continuously, and with the capability and willingness to make adjustments.

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MFR PAPER 982

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Menhaden Tagging and Recovery: Part I—Field Methods for Tagging Menhaden, Genus *Brevoortia*

PAUL J. PRISTAS and THURMAN D. WILLIS

ABSTRACT

This paper describes the methods and equipment used to mark over 1 million menhaden, Brevoortia tyrannus *and* B. patronus, *along the Atlantic and Gulf coasts of the United States from 1966-1971.*

INTRODUCTION

Menhaden occur in Continental Shelf waters from Nova Scotia in the Atlantic to Veracruz, Mexico in the Gulf of Mexico (Reintjes, 1960). By weight of catch, menhaden support the largest fishery in the United States.

The National Marine Fisheries Service (NMFS) expanded its menhaden studies in 1965. A tagging program for Atlantic menhaden, *Brevoortia tyrannus*, was initiated to provide direct evidence of migration patterns, discrete population groups, rates of interchange between fishing areas, mortality rates, growth rates, and identification of important menhaden nursery areas. In 1968 the program was expanded to include the Gulf menhaden, *B. patronus*. This paper describes the methods and equipment used to mark menhaden with an internal ferromagnetic tag.

MARKING MATERIALS

Because vast numbers of menhaden are caught, handled mechanically, and processed into fish meal, marking and recovery requirements are different than those for fish that are caught in smaller quantities and handled individually. Tags must be applied rapidly, so that large numbers of fish can be marked, and they must be recovered mechanically without examining individual fish.

Previous work suggested that an internal ferromagnetic, stainless steel tag, about 14.0 × 3.0 × 0.5 mm, having a specific six-character code, was best for menhaden over 100 mm (Carlson and Reintjes, 1972). Small Atlantic herring were marked with similar tags in Norway (Dragesund and Hognestad, 1960). For juvenile menhaden less than 100 mm, a smaller tag, 7.0 × 2.5 × 0.4 mm, identified with a three character code was needed. Unlike the larger tags, a hundred small tags have the same identifying code.

After testing various tag insertion methods (Kroger and Dryfoos, 1972), we found that inserting tags with a tagging gun designed by the Norwegian firm of Bergen-Nautik[1] yielded the best

[1]Mention of commercial firm does not imply endorsement of product by National Marine Fisheries Service.

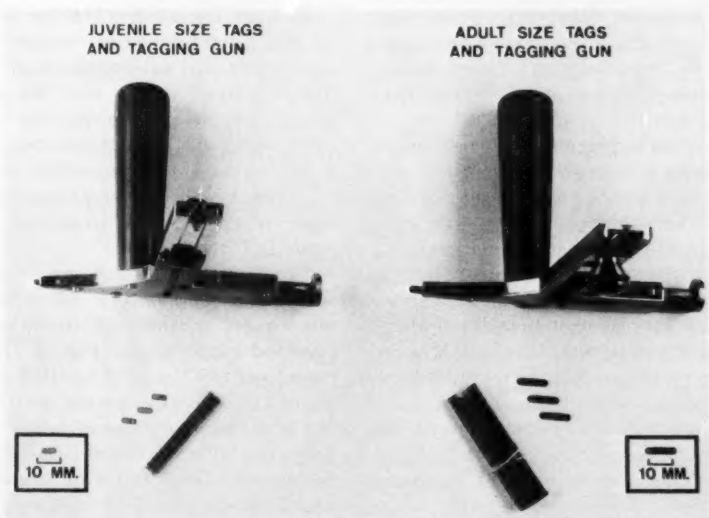

Figure 1.—Adult and juvenile tagging guns with tags and a series of 100 tags taped together.

results. A clip of 100 tags, constituting a series, is loaded into the magazine of the gun. Tags are fed into the barrel by a thumb-operated plunger. Four adult tags or eight juvenile tags fill the barrel with one tag protruding from the end. Each gun can be loaded in less than a minute under favorable conditions and an experienced tagger can tag 600 fish per hour. The adult tagging gun was modified to accommodate juvenile tags.

Tags can best be handled for field work by binding them in groups of 100 with semi-transparent or masking tape. The tape sufficiently adheres to the edge of the tags to hold them together when carefully handled (Figure 1.).

ACQUIRING AND RETAINING FISH

Methods of acquiring and holding fish varied depending upon the source and space available. Most fish were obtained from commercial purse seine catches, although we obtained some from commercial pound nets and caught some in our own pound net, purse seine, surface trawl, and beach seine when commercial sources were not available.

When we obtained fish from the commercial fishery, we either went aboard the carrier vessels and tagged from "live" boxes or followed the vessels in small boats and tagged from holding nets.

When tagging aboard carrier vessels, we dip-netted fish from the purse seine and put them in "live" boxes (0.6 × 0.6 × 1.2 m) which had holes near the top to permit overflow and continuous circulation of water. From 100 to 600 fish, depending on their size, could be held for a short time without mortality. Either a portable water pump or deck hoses on the vessel provided seawater. A frame screen inside the box could be adjusted to various levels to concentrate the fish for quicker handling. (Figure 2). Figure 3 shows tagging aboard a menhaden vessel.

When we tagged aboard our boats, we held fish in a keep-net, 3.7 × 3.7 × 0.9 m, stretched between two 4.9 m cross boards, one of which was cut into two sections (Figure 4). The half pieces make assembly easier and permit the net to be disassembled one section at a time, concentrating the fish for easier removal. The keep-net had a weighted lead line along the bottom to stretch the net downward and help maintain its box shape against a current. The entire cork or float line was ringed with floats to form a barrier prohibiting fish from swimming over the net. This net was very similar to the keep-net used by Fridriksson and Aasen (1950) and from 1 to 2,000 fish could be successfully held for 1 to 2 hr.

Although we usually transferred fish from the purse seines or pound nets by dip-netting or brailing (Figures 5 and 6), we also used a third method when tagging with purse seiners, which we termed "in water". By holding the keep-net and purse seine cork lines together and submerged along one side and raising the opposite side of the purse seine, we forced fish into our net. When we released the cork lines the fish were trapped in our keep-net. About 2 min were required to fill our net (2,000 fish) by this method while brailing took about 5 min and dipping took about 10 min.

We usually held fish in 37.9-liter plastic tubs aboard pound net vessels because there was not enough room for "live" boxes. As fish were brought aboard, they were picked out of the hold of the vessel and placed in the tubs. Ten to 20 fish could be successfully held. Occasionally, when tagging in confined areas, it was necessary to tag fish directly from the hold.

To catch our own fish, we used a small purse seine (61.0 × 3.7 m, 15.9 mm square mesh) with two 4.6-m plywood purse boats (Figure 7), a pound net (45.7 × 15.2 m, 19.1 mm square mesh) (Figure 8), a surface trawl (6.7 m, 6.4 mm square mesh) pulled between two 4.9-m aluminum boats and a beach seine (30.5 × 1.8 m, 6.4 mm square mesh) that was anchored to shore at one end and pulled in a semicircle by an outboard motor boat (Figure 9). The latter method worked well when the fish were close to shore and the shoreline was clear of brush and debris.

Juvenile menhaden were caught in estuaries with surface trawls and beach seines. They were held in small keep-nets (0.6 × 0.6 × 1.2 m, 6.4 mm square mesh) that held about 1,000 fish and were dipped out into 11.4-liter plastic tubs for tagging.

TAGGING FISH

We tagged fish by slipping the tag, protruding from the gun barrel, under the scales and then pushing it through the body wall. By keeping the barrel firmly against the body wall and fully depressing the plunger, the entire tag could be inserted into the body cavity. On fish over 100 mm we inserted the large tag anteriorly from about 13 mm above the origin of the pelvic fin on the right side of the fish (Figure 10); on smaller fish, we inserted the small tag posteriorly from just below the origin of the pectoral fin (Figure 11).

Experiments comparing the survival of fish tagged and released individually as opposed to those released in groups showed a higher survival rate (percent recaptured) for those released individually. Also the rate of survival of individually released fish decreased as the length of time they were held for marking increased. The more uniform, but lower, survival rate of fish tagged and released as a group confirms the importance of immediately releasing the tagged fish, a fact also noted by Mužinić (1965) and Jakobsson (1970). In our field tagging studies, we released fish individually and tried to keep the length of holding time as short as possible.

To determine the age and size of fish tagged, scale samples and fork length measurements were routinely taken from 5 to 25 percent of the tagged fish or from a 20-fish sample taken from the group. A scale-envelope holding board facilitated scale collecting (Figure 12). About 25 scale envelopes were placed on the board which was designed to fit

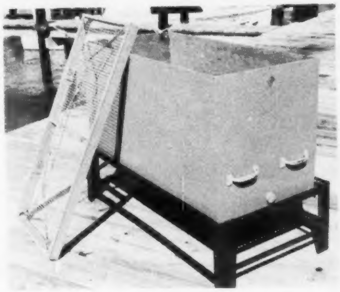

Figure 2 (above).—Live box, stand, and frame screen to concentrate fish for easy handling.

Figure 3 (top right).—Tagging aboard a menhaden vessel.

Figure 4 (below).—Assembled keep-net in water.

Figure 5 (bottom right).—Dip-netting fish from purse seine.

Figure 6 (top).—Brailing fish from a commercial purse seining vessel into our net.

Figure 7 (center).—NMFS purse boats and purse seine being set.

Figure 8 (bottom left).—NMFS pound net.

Figure 9 (bottom right).—Collecting juvenile menhaden with a haul seine.

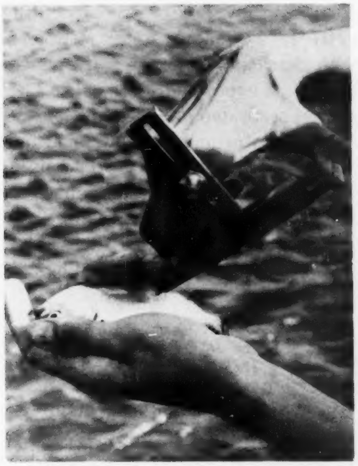

Figure 10.—Tagging young-of-year menhaden.

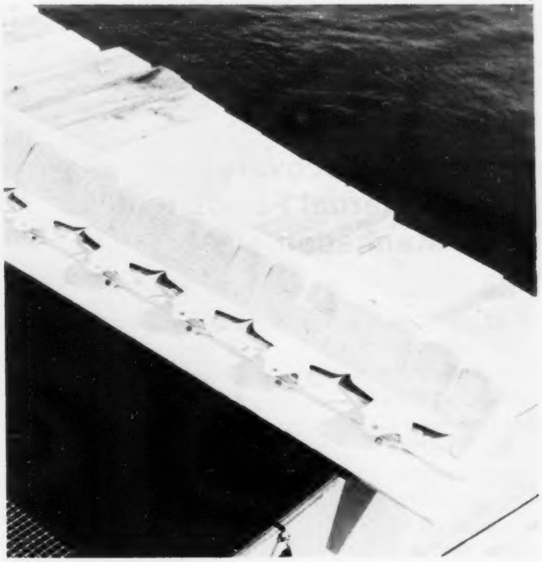

Figure 12.—Scale envelopes mounted on scale envelope holding board.

Figure 11.—Tagging juvenile menhaden.

across the back top of a "live" box, so scales could be inserted through the top.

A flat measuring board was used to obtain fork lengths. Although a trough type measuring and tagging board was later devised to facilitate handling and measuring menhaden larger than 250 mm, we had limited opportunity to use this board and evaluate its effectiveness.

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MFR PAPER 983

Menhaden Tagging and Recovery: Part II—Recovery of Internal Ferromagnetic Tags Used to Mark Menhaden, Genus *Brevoortia*

R.O. PARKER, JR.

ABSTRACT

Plate and rotating grate magnets installed in various locations in reduction plants effectively recover internal ferromagnetic tags used to mark menhaden. Tag recovery efficiency rates for large (adult) tags range from 14 to 97 percent with a mean of 64 percent and for small (juvenile) tags range from 5 to 86 percent with a mean of 39 percent. Magnet installations do not interfere with the reduction operation, but facilitate it by removing scrap metal.

INTRODUCTION

Since Rounsefell and Dahlgren (1933) demonstrated the use of magnets for recovering metallic tags in herring, many scientists have successfully used this method of recovering tags from industrial fish, i.e., species converted to meal, oil, and condensed solubles (Fry, 1937; Fridricksson and Aasen, 1950; Stevenson, 1955; Aasen, Andersen, Gulland, Madsen, and Sahrhage, 1961; Klima and Bayliff, 1961). In addition to magnets, electronic detectors have been used to detect tagged fish among thousands of fish landed (Dahlgren, 1936; Stevenson, 1955; Parker, 1972). These recoveries provide the same information as magnet recoveries, such as migration patterns and mortality rates, and in addition permit the determination of: growth rates, validity of aging techniques, best tag injection location, and time for tag incisions to heal. However, the low efficiency and high cost of detector systems limit their use.

This paper describes the recovery of internal ferromagnetic tags from menhaden plants by magnets. Two sizes of tags are recovered: a large tag, 14.0 × 3.0 × 0.5 mm, used in adult menhaden and a small tag, 7.0 × 2.5 × 0.4 mm, used in juvenile menhaden.

PROCESSING PROCEDURE

At least 96 percent of the menhaden landed annually are processed by reduction plants (Reintjes, 1969). About two dozen plants are active each year along the Atlantic and Gulf coasts of the United States and convert millions of menhaden daily to meal, oil, and condensed solubles.

As the catch is unloaded, it is weighed automatically before being transferred to the plant by a drag line or screw conveyor. In the plant, fish are temporarily stored in a raw box or are carried directly to a steam cooker. Cooked menhaden enter a screw press which produces a liquor and press cake. The liquor is separated into oil and stickwater by centrifuging or settling, and the stickwater is evaporated to condensed solubles. The press cake is conveyed through a rotating dryer to a scrap shed for storage. Later, scrap is either shipped in bulk or ground into meal before shipping.

MAGNET INSTALLATIONS

All companies install magnets to reduce metallic contaminants in the product and prevent damage to equipment. Most companies have two-pole plate magnets in chutes conveying material to grinders, and some plants have drum magnets turning the terminal end of conveyor belts. Electromagnets are also used in some plants.

In addition to company-owned magnets, we installed a variety of magnets at various locations in the plants to increase tag recovery efficiency and minimize the delay between processing and recovery. In drag lines and chutes we installed two-pole and four-pole plate magnets (Figure 1). The pulling power of these magnets (304.8 mm long) at a distance of 50.8 mm for a standard test piece of 76.2 × 25.4 × 3.2 mm cold-rolled steel was 141.8 g and 106.3 g. More recent installations of plate magnets have been of the two-pole type with a pulling power of 510.3 g. In many plants where scrap drops from conveyors, we installed rotating grate magnets (Figure 2). These grates are cylindrical with several magnetic bars, 25.4 mm in diameter, spaced 76.2 mm apart. The cylinders are rotated with electric motors at 12 rpm. We abandoned stationary grate magnets after initial tests because they often became clogged. Magnet installations do not in-

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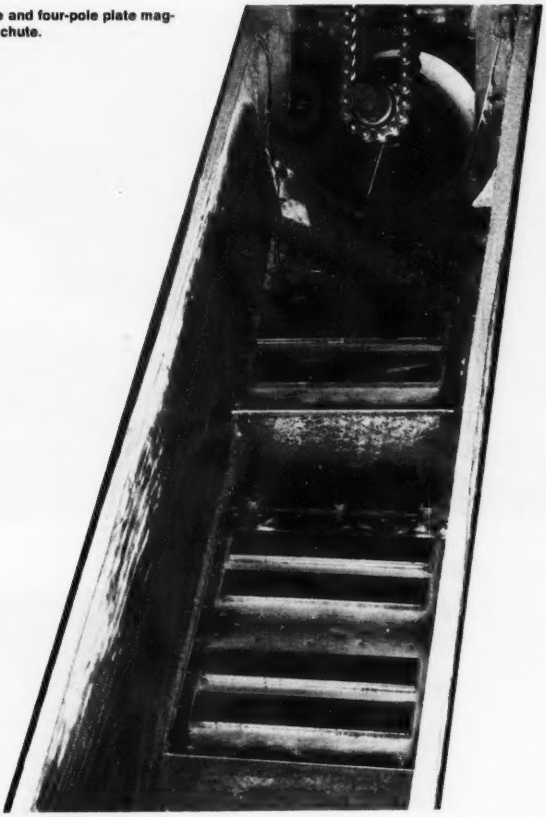
Figure 1.—Two-pole and four-pole plate magnets in a conveyor chute.



terfere with the reduction operation, but facilitate it by removing scrap metal.

All magnet installations have been designated as primary or secondary locations based on the length of delay between the time of landings and passage of fish scrap over the magnets. Primary installations, between the dryer and scrap shed, search scrap the day fish are landed, except during heavy landings when fish must be stored for a day or two in raw boxes. Secondary installations, usually in the scrap shed just ahead of the grinders, search scrap at irregular intervals, sometimes months after fish are landed.

TAG RECOVERY

Magnets are usually cleaned daily. To facilitate cleaning, some magnets are attached with hinges and a latch (Figure 3). Others are covered with a metal plate quipped with a handle, permitting all material to be lifted at once (Figure 4). Metal and fish scrap are scraped into buckets and the magnet number (identifying the plant and magnet location) and date are recorded. The material is spread on the floor and a magnetic sweeper is passed over it several times to concentrate the metal (Figure 5). The metal is searched by hand for tags (Figure 6). If there is a large quantity of scrap metal, the bulk of it is separated from the tags with sieves (Figure 7). Recovered tags are sealed in small envelopes identified by magnet number and date. Later, the tags are taped to forms on which all recovery information is transferred. The forms are checked and sent to computer processing. Tens of thousands of tags are recovered annually (Coston, 1971).

EFFICIENCY TESTS

Tests are conducted weekly throughout the fishing season to monitor magnet and plant tag recovery efficiencies under various conditions. From these tests we evaluate magnet installations and estimate the number of field tags entering the plants. Magnet installation efficiency is determined by scattering 100 tags in the scrap just before it passes

Figure 2.—A rotating grate magnet removes metal from scrap as the scrap drops from a conveyor.

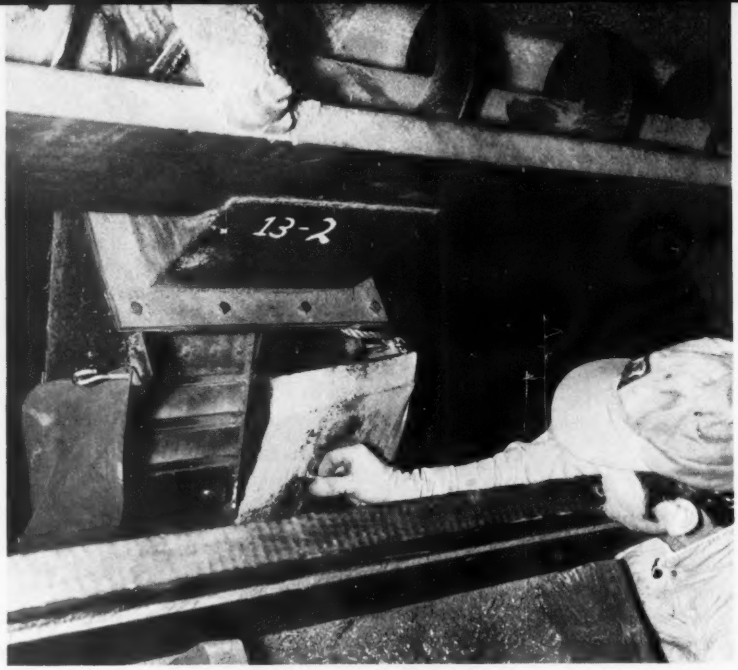


Figure 3 (above).—Hinged magnets facilitate cleaning.

Figure 4 (top right).—A metallic magnet cover with a handle permits all material to be lifted at once.

Figure 5 (below).—Metal and fish scrap are separated with a magnetic sweeper.

Figure 6 (center right).—Metal is searched by hand for tags.

Figure 7 (bottom right).—Sieves help separate scrap metal and tags.

over the magnets. The percent of test tags recovered on the magnets is a measure of the efficiency of the installation. Tag recovery efficiency at a plant is determined by distributing 100 tagged fish in the hold of a fishing vessel, in the conveyor system between dock and plant, or in raw boxes. Because of the delay between primary and secondary installation recoveries, weekly plant tag recovery efficiency is determined from test tags recovered on primary installations only. Seasonal tag recovery efficiencies are based on both primary and secondary recoveries. Test tag and field recoveries are recorded alike.

Magnet installation efficiencies for large tags range from 18 to 100 percent with a mean of 71 percent; seasonal recovery efficiencies range from 14 to 97 percent with a mean of 64 percent. No tests of magnetic installation efficiencies were conducted with small tags since these tags were not developed until our third year of tagging. Seasonal recovery efficiencies for small tags range from 5 to 86 percent with a mean of 39 percent. In some plants large numbers of tags are lost in cookers and dryers in addition to losses through magnet inefficiency.

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MFR PAPER 984

Japan's culture of eels quadrupled in the 1960's; new sources of supply are sought.

Japan's Eel Fishery

WILLIAM B. FOLSOM

INTRODUCTION

The Japanese have been eating eels (called "unagi" in Japanese) since prehistoric times. Eels are usually served as "kabayaki" (broiled strips of eel on skewers flavored in a mixture of soy sauce, sugar, and "mirin"—a sweet rice wine) and "unagi donburi" (kabayaki—without skewers—served in a bowl of hot rice). Traditionally the Japanese feast on eels during "Ushinohi" (the Day of the Ox) in mid-July. The Japanese believe that eels give them the energy to beat the hot summer weather.

In recent years the price for eels in Japan has reached astronomical heights; a few thin slices of broiled eel, served with a bowl of rice, costs several dollars in a Tokyo restaurant. In April 1971 the Japanese newspaper *Yomiuri* reported that live, Japanese-bred elvers (baby eels) could be sold for US$147.27 (US$1 = 360 yen) per pound at Hamamatsu in Shizuoka, Japan. Mr. Clinton E. Atkinson, U.S. Regional Fisheries Attaché in Tokyo, reports that a Japanese firm quoted a retail price for Japanese elvers as $417 (US$1 = 260 yen) per pound in February 1973. He adds, however, that retail prices for eels are misleading since there is no true retail price; prices fluctuate greatly and are dependent upon a variety of conditions.

(Opposite.) Eel culture ponds at Yoshida-Machi (Shizuoka Prefecture). Photograph by Kazutami Nishio, Maruhai Yoshida Eel Research Laboratory, Yoshida-Machi, Haibara-Gun, Shizuoka Prefecture, Japan.

CATCH

Japan's catch of eels between 1952 and 1970 (Table 1, Figure 1) has ranged between 1,700 and 3,400 metric tons and appears to be decreasing. One reason for the apparent decline in catch has been the growing pollution of Japan's coastal waters and rivers. In early January 1972, for example, fishermen along the coast of Shizuoka Prefecture complained that they caught only two tons of eels in an area which once saw catches of between 20 and 30 metric tons per year. The construction of hydroelectric dams in Japan has also adversely affected the eel fishery. Finally, overfishing, especially on the reduced stocks, has contributed to the decline in catch in recent years.

Japan's most important species of eel is *Anguilla japonica*, which spawns in the Pacific Ocean. The elvers are caught by Japanese fishermen for sale to eel culturists and restaurants as they enter Japan's rivers from December through May (February to March is the heaviest period). Those that survive the fishermen, pollution, dams, and natural predators, live in the waters between mouths and upper reaches of Japan's rivers. They grow for a period of between 5 to 20 years until they reach sexual maturity; then they migrate downstream and enter the ocean to spawn. This migration of mature eels—or silver eels—usually occurs between August and October of each year. After spawning the adult eels are believed to die.

CULTURE

The Japanese have cultured eels since 1879. However, eel culture did not begin to flourish until the early 1960's. Between 1962 and 1968-69, the harvest of cultured eels increased from 7,600 tons to slightly more than 23,000 tons. Then in 1970, production dropped to 16,700 tons, causing prices to soar.

The sharp drop in production in 1970 was caused by a mysterious disease which affected the gills and kidneys of the cultured eels. Many thousands died overnight. Losses ran into the millions of dollars. Many Japanese believe that the disease was introduced with the first imports of elvers from Europe in 1969. The eel, under culture conditions, is subject to 10 different types of disease which can easily wipe out an eel farm overnight. These problems, plus their

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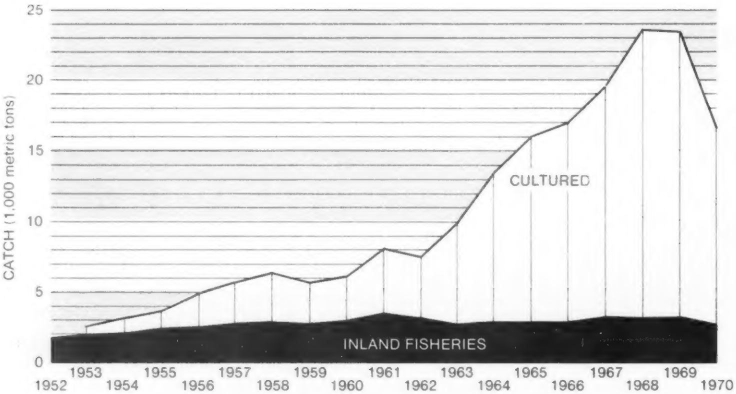


Figure 1.—Catch of inland eels and culture of inland eels, 1952-70.

sensitivity to pollution—in addition to problems of artificially breeding eels —have limited the propagation of eels in Japan.

In spite of these many difficulties, the culture of eels in Japan is an important and profitable business. Sanders (1971), in *Australian Fisheries*, reported on the methods used by the Japanese in culturing their eels:

> Elvers are caught in the winter as they migrate upstream from the spawning grounds in the open sea, and are cultured in relatively small ponds of 150 to 350 square meters by 70 cm deep. This phase of culture lasts for about one year, during which time the young eels grow to about 20 gm in weight. The original stocking density is about 500 to 600 gm per square meter.
>
> The growth of individual eels is tremendously variable and constant culling is required during all stages of culture to ensure approximately uniform sizes in each pond.
>
> When elvers begin feeding they are given small oligochaete worms for about two to three days, then for seven to 10 days a paste of mixed oligochaete worms and fish flesh. Then they are weaned on to fish flesh or synthetic diets especially formulated for eels. They are fed twice a day and the quantity of feed given is about 30 percent of body weight.
>
> Young eels prefer to eat in a darkened place and feeding is done in a shelter at one side of the pond. The food is placed in a wire basket suspended just above the water to prevent undue contamination of the water. When young eels reach a weight of 20 gm they are ready for the next phase which takes them to adulthood.
>
> The aim of adult culture is to produce 150 gm eels for market and this is achieved in about two years from the elver stage, which is double the growth rate of wild eels. The size of the adult ponds is about 3,000 to 10,000 square meters by 50 cm deep. The stocking rate is about 500 to 700 gm of seed eels per square meter of pond. Growth is most rapid during April to October and during the period the eels must be fed as much as possible. The quantity of food supplied is about 10 percent of body weight and is fresh or frozen fish flesh or synthetic diets. If fish flesh is used the feed coefficient is 6 to 7 while for synthetic diets it is less than two.
>
> During culture care must be taken to maintain a satisfactory water quality. As all phases of culture are in still water and the density of stocking is high, the maintenance of water quality is relatively difficult. PH levels in the water should be about 8.0 to 9.2 during the daytime, and about 6.8 to 7.2 at night.
>
> Ponds located on acid soils usually have a PH around 5.5 to 6.5 which is too low for satisfactory eel culture. A high dissolved oxygen level is absolutely necessary and the minimum desirable value for eels is 2.0 to 2.5 cc per litre. Water wheels which oxygenate and mix water layers are a common feature of eel ponds. Satisfactory levels of calcium nitrate and phosphate should be maintained and this can often be done by the addition of fertilisers.
>
> Ponds are usually drained and the bottom mud turned and sprinkled with lime at the end of each year.
>
> The species composition and abundance of micro-organisms is of considerable importance during eel culture. In general phytoplankton are beneficial to eel culture and zooplankton are not. Well managed eel ponds are a blue-green color, with a plankton composition of 0.3 to 2.9 percent zooplankton and 97.1 to 99.7 percent phytoplankton.

Table 1.—JAPAN. Catch and culture of inland eels; 1952-1970.

YEAR	EEL CATCH AND PRODUCTION		TOTAL
	Inland fisheries catch	Eel Culture	
	— — *1,000 Metric Tons* — —		
1952	1.7	—	1.7
1953	1.9	2.5	4.4
1954	2.0	3.1	5.1
1955	2.3	3.6	5.9
1956	2.4	4.9	7.3
1957	2.7	5.7	8.4
1958	2.8	6.3	9.1
1959	2.7	5.7	8.4
1960	2.9	6.1	9.0
1961	3.4	8.1	11.5
1962	3.1	7.6	10.7
1963	2.7	9.9	12.6
1964	2.8	13.4	16.2
1965	2.8	16.0	18.8
1966	2.8	17.0	19.8
1967	3.2	19.6	22.8
1968	3.1	23.6	26.7
1969	3.2	23.3	26.5
1970	2.7	16.7	19.4

FAO, Yearbook of Fishery Statistics, Rome, various years.

MARKETING

The Japanese classify eels according to size and maturity. For culture purposes, the Japanese prefer the smaller sizes and will pay higher prices for them; the larger the eels, the lower the price. The so-called "glass eel" (an elver which has just entered fresh water and is still translucent or white in color—called "shirasu" in Japanese) commands premium prices. "Kuroko" (elvers usually over a week in fresh water and black in color) are the next most

popular. Other larger-sized elvers are also designated by special names.

The market price for the different size categories of eels is dependent on the season, supply conditions, their fat content, taste, and freshness (live eels are preferred).

In 1971, the Japanese wholesale price for elvers generally ranged between $66 and $83/lb; juveniles sold for between $35 and $50/lb, while adult eels sold for between $2.50 and $3.00/lb (US$1 = 360 yen). These prices were generally paid for Asian eels, which normally command better prices on the Japanese market.

IMPORTS

Faced with a growing demand and potentially lucrative profits, but plagued with supply difficulties, the Japanese have turned abroad to find new sources of elvers for their eel farms. In 1970 Japan imported 290,347 pounds of elvers valued at $6.1 million (Table 2). In 1971, imports reached almost 700,000 pounds (Table 3), and in 1972 (Table 4) slightly over 450,000 pounds.

Prices published in Japanese fishery newspapers indicate that the Japanese are willing to pay more for eels of Asian origin. In October 1972, a trade journal reported the Japanese import price for live, adult eels from Taiwan was $2.58 to $2.72/lb compared with $3.63 to $4.09/lb during the summer months. In November 1972, that newspaper reported the sale to Japan of some 900 kilograms of elvers [CIF (cost, insurance, freight) Hong Kong] by Mainland China at the following prices:

Eels per kilogram	*Dollars per pound (US$1 = 308 yen)*
300 - 500	20.56
500 - 1,000	30.85
1,000 - 1,200	41.13
2,000 - 3,000	61.70
3,000 - 4,000	82.27
4,000 - 6,500	113.12

In contrast, the prices quoted to potential U.S. exporters were considerably lower. On October 30, 1972, the Regional Fisheries Attaché cabled the

Table 2.—JAPAN—Imports of elvers, by quantity, value [C&F (cost and freight) Tokyo], and by country; 1970.

COUNTRY	QUANTITY	VALUE	AVERAGE PRICE PER POUND
	Pounds	*US Dollars (Dollar = 360 yen)*	*US$1.00/lb.*
Okinawa	4	208	52.00
South Korea	23,579	760,730	32.26
China, Taiwan	221,960	4,836,530	21.79
China, Mainland	44	930	21.13
Hong Kong	110	2,063	18.75
France	22,849	273,605	11.97
Great Britain	7,891	87,719	11.11
New Zealand	455	3,994	8.97
Italy	13,455	110,622	8.22
Total	290,347	6,076,401	20.93

Table 3.—JAPAN—Imports of elvers, by quantity, value [C&F (cost and freight) Tokyo], and by country; 1971.

COUNTRY	QUANTITY	VALUE	AVERAGE PRICE PER POUND
	Pounds	*US Dollars (Dollar = 360 yen)*	*US$1.00/lb.*
France	51,924	594,530	11.45
Italy	16,041	165,704	10.33
Great Britain	10,056	114,605	14.38
Taiwan	595,465	7,336,129	12.32
South Korea	21,342	909,383	42.61
China, Mainland	2,757	126,491	45.88
Hong Kong	387	14,249	36.82
Canada	326	2,927	8.98
United States	81	994	12.27
Total	698,379	9,265,012	13.32

Table 4.—JAPAN—Imports of elvers, by quantity, value [C&F (cost and freight) Tokyo], and by country; 1972.

COUNTRY	QUANTITY	VALUE	AVERAGE PRICE PER POUND
	Pounds	*US Dollars (Dollar = 308 Yen)*	*US$1.00/lb.*
France	145,418	1,701,391	11.70
Italy	5,082	73,841	14.53
Great Britain	17,688	247,101	13.97
Taiwan	250,983	5,057,307	20.15
South Korea	29,482	1,737,964	58.95
China, Mainland	3,269	n.a.	n.a.
Hong Kong	350	1,929	5.51
United States	891	3,395	3.81
Philippines	2,013	68,904	34.23
New Zealand	3,441	47,589	13.83
Total	458,617	[1]8,939,421	19.63

[1]Does not include Mainland China.

prevailing CIF-Japan prices for eels as follows: (US$1 = 308 yen):

Live elvers (2,700 eels/lb) . . . . $15.91 to $18.18/lb
Live elvers (1,400 to 1,600 eels/lb) . . . . $ 8.18 to $ 9.09/lb

Live adult (150 to 200 grams per eel) . . . . $1.23 to $1.36/lb
Frozen adult (150 to 200 grams per eel) . . . . $0.22 to $0.27/lb

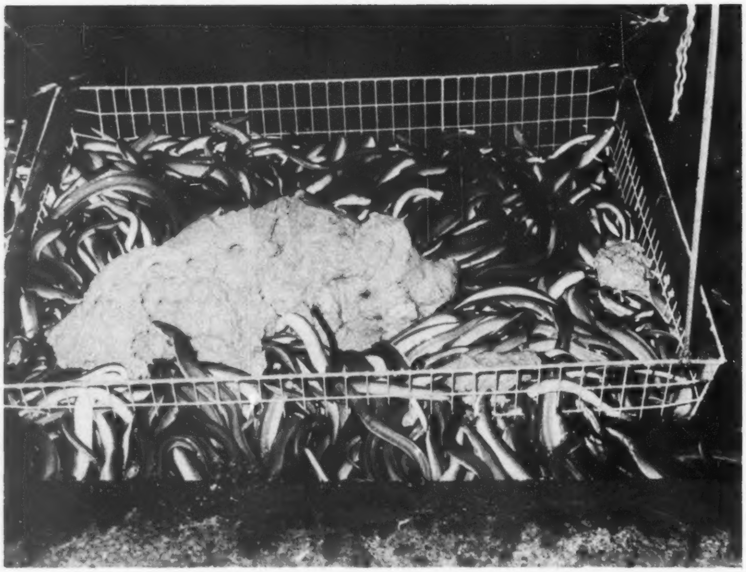
The Regional Fisheries Attaché discussed these price differences with Japanese importers. Their responses, with his comments, are:

American/European eels are different species, and the quality of meat (oil, taste) differs.

On the contrary, Dr. Isao Matsui,

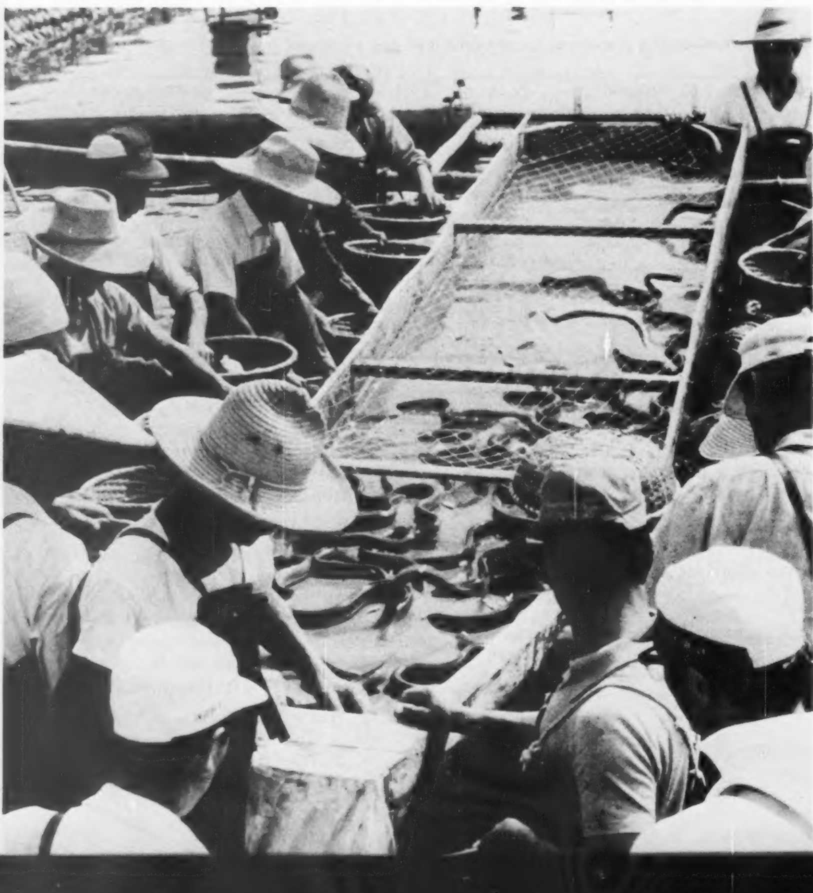
Japan's leading eel expert, told the Attaché that variations caused by differences in culture environment can be much greater than variations between species. This is borne out by recent reports from the industry that some Japanese dealers actually prefer Japanese-cultured European eels to Asian eels.

Mortality is high on imported eels and prices must allow for this loss.
Shipping of elvers and adult eels is an extremely complex operation. Eels exude slime when subject to stress and they can suffocate in transit unless shipped properly. Poor handling in shipment, delays en route, and other complications also contribute to mortality. These potential losses must be taken into consideration.



(Above) Eels feeding in culture ponds, Yoshida-Machi (Shizuoka Prefecture). Photograph by Kazutami Nishio, Maruhai Yoshida Eel Research Laboratory, Yoshida-Machi, Haibara-Gun, Shizuoka Prefecture, Japan.

(Below) Sorting cultured eels, Yoshida-Machi (Shizuoka Prefecture). Photograph by Kazutami Nishio, Maruhai Yoshida Eel Research Laboratory, Yoshida-Machi, Haibara-Gun, Shizuoka Prefecture, Japan.



American/European eels are received later in the growing season which affects their growth and early marketability.
There is some truth to this, but the difference between Japan (March-April) and Maine (April-May) appears to be small.

American/European eels are adapted to cooler water than Asian eels and grow slower.
Recent studies show that temperature, along with a susceptibility to a *cyclochaete* parasite, to be the major problems in rearing European/American eels in Japan. Considerable research is now in progress in Japan in an attempt to develop more suitable methods to rear European/American eels.

Asian eels are collected and sold at a younger age when they are smaller in size and the number per pound is greater.
This is certainly true, but this problem could be overcome by concentrating on smaller eels and proper holding methods.

In addition to these factors there are additional barriers preventing the ex-

port of larger-sized eels to Japan. The Japanese charge an import duty on eels, as follows:

Description	*Duty*
Young eels for culture (Up to 13 grams/eel)	Free
Live or frozen eels (13 grams/eel or more)	5% ad valorem
Sliced & precooked eels	12% ad valorem

U.S. EXPORT OPPORTUNITIES

Although American eels *(Anguilla rostrata)* have already been sold on the Japanese market (the initial reaction was good), the process is not a simple one. The Japanese—with centuries of eating eels behind them—are reluctant to try something new, even a similar product from a new source. Japanese importers will invariably ask for a number of samples, analyze them from every angle, conduct taste tests, and then offer a price that allows for all kinds of possible contingencies. In view of this, the Regional Fisheries Attaché suggests that U.S. exporters try to keep their first orders near the break-even point, until a market has been firmly developed. Then, as the demand grows, competition between buyers will gradually force the price up.

Inquiries of those who wish to export eels to Japan can be addressed to:

Japan Marine Products Importers Association
Sanshi Kaihan Bldg.
1-7, Yuraku-cho, Chiyoda-ku
Tokyo, Japan.

For a list of Japanese fishing and trading firms located in the United States, write to:

International Activities Staff, (Fx-41)
National Marine Fisheries Service, NOAA
U.S. Department of Commerce,
Washington, D.C. 20235

ACKNOWLEDGMENT

The assistance provided by Mr. Clinton E. Atkinson, Regional Fisheries Attaché, U.S. Embassy, Tokyo, in reviewing this paper is gratefully acknowledged. Mr. Atkinson also provided much of the source information.

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MFR PAPER 985

Elver Investigations in the Southeast

ROBERT TOPP and RICHARD RAULERSON

The true American eel, *Anguilla rostrata*, is widely distributed throughout states bordering the Gulf of Mexico and Atlantic Ocean. Several Atlantic states have historically utilized a small percentage of the adult eel for commercial purposes. However, only recently has the possibility for utilizing the juvenile eel (elver) emerged.

The present interest in commercial harvest of elvers stems from a combination of factors affecting the Japanese adult eel market. Rising per capital incomes in Japan have strengthened the demand for adult eels, while the supply of Asian eels, *Anguilla japonica*, has declined owing to environmental factors and increased fishing pressure. During the 1960's the Japanese turned to mass culture of eels to supplement the wild and imported eels (see accompanying article, *Japan's Eel Fishery*, by William B. Folsom). Mass culture of eels in turn has been limited by availability of fingerlings or elvers. Furthermore, eel breeding techniques have not been developed and probably will not be for the foreseeable future. Hence, the Japanese have begun rather serious investigations into the possibility of securing supplies of American elvers.

This Japanese interest resulted in a trip to the United States by an investigative team of Japanese eel experts. The team, composed of Dr. S. Nishimura, economist, Fisheries Agency, Hino-Shi, Tokyo, Japan and Mr. K. Nishio, head of eel culture, Maruhaiyoshida Fisheries Cooperative, Shizuoka, Japan, was hosted by Dr. Evan Brown, economist, University of Georgia. Actual elver investiga-

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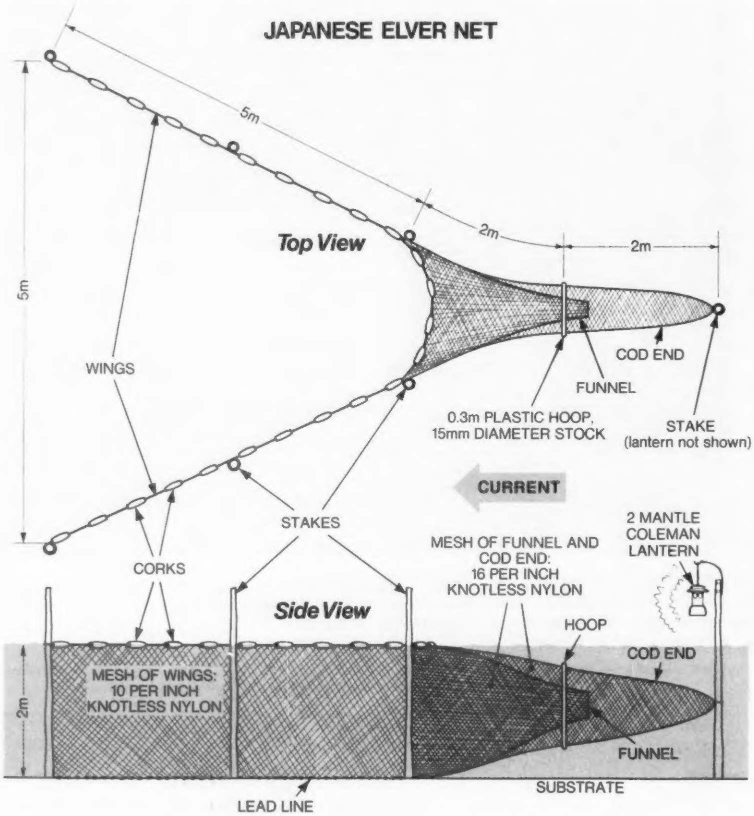

Japanese elver net. (Above) Top view. (Below) Side view.

tions were conducted by the Florida Department of Natural Resources and industry in North Carolina with coordination provided by NMFS.

ELVER FISHING TECHNIQUES AND RESULTS

Exploratory fishing was conducted approximately 75 miles from the mouth of the St. Johns River (Florida) on March 5-7, 1973. Three fishing techniques were attempted—the modified fyke net, dip net, and a crude trotline arrangement.

Two modified fyke nets of a standard commercial size employed in Japan (see accompanying drawings) were supplied by the Japanese visitors. These were set at varying distances from shore, in depths of less than 2 meters. The nets are fished at night with a Coleman-type lantern. It is significant that they fish downstream and are therefore only available to elvers moving actively upstream and/or towards the light source. This method of fishing yielded about 300-500 glass-stage elvers in the size range of approximately 3,700 per pound. This is not a commercial quantity by any means, but the fact that desirable glass-stage elvers were present greatly encouraged the Japanese visitors. They believed that taking commercial quantities of elvers would simply involve being in the right place at the right time in the future.

The dip net was employed at a dam on a St. Johns River tributary. The possibility of locating elvers immediately downstream from a dam had been reported to several members of the exploratory fishing party and this was verified by a local fisherman who helped the party capture seven pounds of elvers in about one hour on the night of March 7. These elvers were at a more mature black-stage and averaged about 50 per pound. It appears that fishing some type of gear below a dam under the right conditions may yield commercial quantities of elvers. Several additional pounds of elvers were taken from this site and shipped to Japan during the following week.

The third technique employed was an unusual trotline arrangement, (termed the "primitive method" by the Japanese) consisting of a trotline with 3-foot droppers attached about every 10 feet. Finely branched weighted brushes are tied to the droppers and the gear is set next to the bank overnight. The gear is pulled after daylight by carefully lifting the individual droppers and shaking the catch into a small net. No elvers were taken by this method.

Subsequent to the exploratory fishing efforts on the St. Johns River, the Japanese attempted to capture elvers from the Suwanee River in Florida and the Neuse River in North Carolina. However, these efforts were not successful.

ELVER HOLDING AND SHIPMENT

As elvers are captured, they are temporarily placed in a small holding net for transport to a shore facility. On shore they are placed either in a holding pen in the natural waters or in a suitable aerated tank. The most promising method of shipment involves transportation on ice. Specially designed styrofoam containers which hold about 10 pounds of elvers, mixed with crushed ice, are packed in 50-pound master cartons and shipped by air. At present, the Japanese desire to have elvers shipped to Los Angeles, where they are again placed in holding tanks and observed for a several-day period prior to being airshipped to Japan.

Florida Department of Natural Resources Biologist Roy Williams and University of Georgia professor Evan Brown observe as Japanese experts K. Nishio and S. Nishimura adjust an elver net on an exploratory fishing trip in the St. Johns River at Palatka.

WHAT HAPPENS NEXT?

The elvers obtained in Florida are currently being tested in Japan for possible disease problems, adaptability to a culture pond environment, and growth potential. Indications are that the outlook is favorable that the Japanese will actively seek elver supplies from the United States during the next elver "run" season which is generally through to occur between November and May, depending on geographical location. Even if commercial quantities are not purchased next year, it is probable that the Japanese will send additional teams to the United States to determine the time and extent of elver runs in our rivers. If they are not able to send technicians over, they will attempt to interest state agencies and private industry in determining the extent and timing of the elver fishery.

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MFR PAPER 986

More than half of all species of vertebrates (animals with backbones) are fishes. Here a renowned biologist discusses the...

Structure and Senses of Fish

RALPH HILE

THE "TYPICAL" FISH

If one were required to "describe a bird," he doubtless would be distressed at the necessity of covering in a single account the tiny hummingbird, the soaring eagle, and the bulky, perpetually grounded ostrich. Even if assigned a much smaller group of animals, such as the dog, he would give no little thought to the range from the Mexican hairless to the sheep dog or from the bulldog to the whippet. In either situation the final description unquestionably would be couched in vague but commendable generalities.

Affairs are no different with the description of "a fish". If anything, fishes offer an even thornier problem than do birds or dogs. In the first place, they are an extremely numerous group and accordingly one with great latitude for variation. Indeed, more than half of all species of vertebrates (animals with backbones) are fishes. Furthermore, fishes have adapted themselves to an enormous variety of environments. On the one hand they are to be found in the icy waters of the polar regions, while on the other, they can exist miraculously uncooked in hot desert pools up to temperatures well above 100°F. They may roam widely over the vast expanses of the open sea or spend their entire existence in the cramped, underground quarters of an artesian well. They thrive in high mountain lakes and in the abyssal depths of the ocean. They may even desert temporarily the aquatic habitat to scamper over mud flats or climb small trees in search of food. If pools dry up, they may bury themselves in the mud and spend the dry season breathing air. Only the most extreme conditions—as the briny waters of the

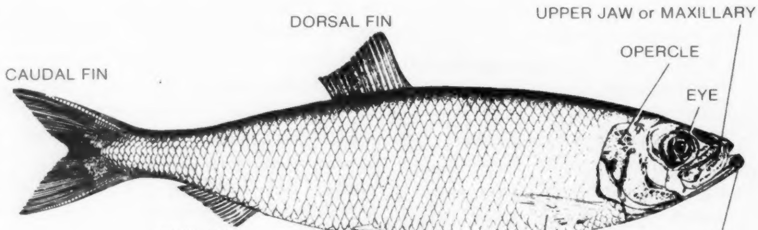


Figure 1.—External structure of the Atlantic herring, *Clupea harengus harengus.*

Ralph Hile, P.O. Box 604, Ann Arbor, MI 48107, joined what was then the Bureau of Fisheries in 1930 and retired from the National Marine Fisheries Service, its successor, in 1970. He is widely known for his many papers on fishes and fisheries. This paper is a slightly revised version of his Fishery Leaflet 132, first issued in 1949, reprinted eight times, but for the past several years out of print.

Great Salt Lake or the foully polluted areas that man has created—can defy them. On the whole, it can be said that where there is water, there are fishes —and three-fourths of the earth's surface is covered with water.

The diversity of size and structure of fishes is much as would be expected in a group adapted to live under such a wide range of conditions. Sizes run the full gamut from certain Philippine gobies that may be only a half-inch or less in length when fully grown to the whale shark which certainly attains a length of 40 or 50 feet and possibly may reach 70 feet. Shapes are equally variable. As extreme examples we may cite: the elongate eel with its snake-like body that so often gives rise to erroneous suspicion of reptilian affinity; the skates and rays which look like they have been flattened by a roller; the ocean sunfish with a body as deep as it is long; the globular puffer; the flounders and soles with both eyes on the same side of the head; and the ever-popular seahorse, which at first glance would hardly be detected as a fish. The preceding are merely selected illustrations of the extraordinary extremes in the size and shape of fishes, not a few of which approach the monstrous.

Yet, for all their variability, a bird is still a bird, a dog is still a dog, and a fish is still a fish. Furthermore, the fullest realization of the existence of wide variations and unusual extremes does not preclude the formation of reasonably definite concepts of "typical" or "average" animals. These concepts, to be sure, are likely to be colored somewhat by personal experience. On the whole, however, they are fully valid since almost all of them will bear close resemblance to all kinds of birds, dogs, and fishes most commonly encountered.

The establishment of the propriety of discussion in terms of a typical animal is vital to the present argument, for it would be futile to attempt within the space of a few pages a description of structure and special senses that would hold even approximately for all fishes. The sections that follow accordingly were written largely with a single species, the North Atlantic marine herring, in mind. Supplementary comments are introduced, however, to bring out certain of the more striking specializations.

There is much to recommend the herring *(Clupea harengus)* for selection as our typical fish. First, it is one of the most abundant food fishes in the world. Second, it is an inhabitant of the open ocean, an area in which a high percentage of all species of fish live. Finally, the herring is relatively unspecialized and consequently exhibits no extremes in size, form, or structure.

EXTERNAL STRUCTURE AND PRINCIPAL ORGAN SYSTEMS EXCLUSIVE OF SPECIAL SENSE ORGANS

External Features

The external structure of the herring (Figure 1) is admirably designed to offer a minimum of resistance to movement through the water and hence to insure the maximum speed and efficiency in swimming. In outline the body is spindle-shaped although somewhat heavier toward the front than toward the rear; the cross-section is elliptical. The head is integral with the body—that is, a neck is lacking. So effective is this natural streamlining that man-made objects constructed to move with a minimum of resistance as, for example, the submarine, invariably take on a similar shape. Nor is the body form the only provision for free movement through the water. The body surface is generally free from projections that might offer resistance. The eyes are smooth and do not extend beyond the contours of the head; the gill opening is covered with a smooth flap (operculum); and the scales lie closely against the body surface. Resistance is lessened still further by an over-all coating of slime.

Only the fins extend beyond the body, and they have been demonstrated by means of experiments with objects constructed to resemble the body of a fish to be essential to stability in the water. During rapid swimming the fins may be depressed or folded along the body so as to minimize resistance. Erect, they serve well as brakes.

Fins are of two general types—paired and unpaired or median. The paired pectoral and pelvic (known also as ventral) fins which are attached to the girdles bearing the same names correspond to the fore- and hind-limbs of terrestrial vertebrates. The relative positions of the paired fins vary considerably among fishes, and in some (as the eels) the pelvics or even the pectorals may be entirely lacking. The unpaired fins are dorsal (on the back), caudal (the tail), and anal (on the belly). Fishes never have more than two pairs of paired fins, but the number of dorsal and anal fins is variable.

In the herring the fins are supported by soft "rays," but in many species (as the yellow perch) the front part of the dorsal and anal fins and the outer parts of the paired fins are supported by bony spines. These spines give the fins greater rigidity and also provide organs of offense and defense.

Fins of fishes exhibit numerous remarkable modifications, a description of which would require many pages. Among the most interesting may be mentioned the enormously developed pectorals of the flying fish which enable that animal to "fly" or more properly to glide through the air over distances of several hundred yards. Possibly the most fantastic modification of a fin is found in the angler-fish in which the first spiny ray of the dorsal fin, greatly elongated, highly flexible, and with a flap-like structure at the tip, is located on the snout in such a position as to serve as a

line and bait to attract unwary fish into the angler's capacious mouth. In some species the "bait" at the end of the line consists of a bulb that can be made luminous as desired and in one this bulb is further equipped with a series of horny hooks!

The streamlined structure of the herring that was emphasized at the beginning of this section is characteristic of the pelagic inhabitants of the ocean and of other fishes that depend on speed of movement to capture or to avoid becoming food. Any substantial deviation from this streamlining inevitably detracts from swimming efficiency and requires a way of life in which speed and agility are not fundamental to survival.

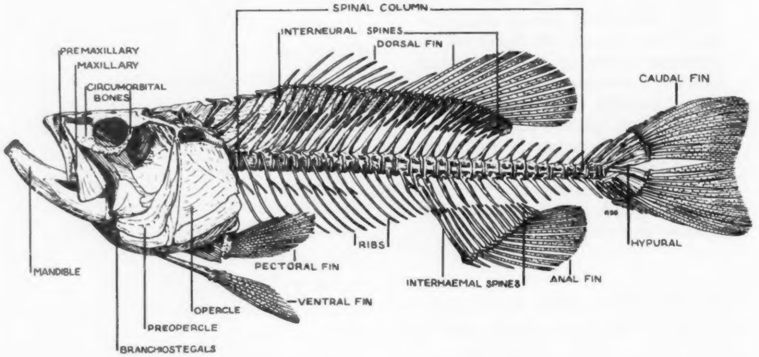


Figure 2.—Skeleton of smallmouth bass, *Micropterus dolomieui.* **Skeleton drawn by Mrs. Ann S. Green.**

Skin

The streamlining of fishes is carried over to the skin, which in all probability fits more closely than the skins of other vertebrates. Fishes need have no fear of developing bagginess and wrinkles with advancing age.

A primary function of the skins is the provision of a relatively impervious, tough, and elastic protective covering. The effectiveness of this protection is increased greatly in most fishes by the presence of scales. Scales may be considered characteristic of fishes; their absence (as in many catfishes) or reduction to insignificant size (common eel) represents special development. In structure, scales range from the toothlike scale of the shark (indeed, the teeth of the shark are nothing more than modified scales) and the heavy, bony plates of the sturgeon to the more common types to be found on such "teleost" or "bony" fishes as the herring, brook trout, or sunfish. The scales of the teleost fishes are imbricated—that is, they overlap more or less in the manner of shingles. A feature of the scale structure of many fishes that is particularly valuable to scientists is the "annulus" or year-mark which permits the determination of age.

Also located in the skin are certain sense organs (which will be mentioned again later), numerous glands (including the mucous glands and the unusual light-producing organs of deep-sea fishes), and the color cells that are responsible for the intricate and occasionally gaudy patterns to be found in some fishes. The skin serves further as the depository for a waste product known as guanin, which has the power of reflecting light and thus can produce white, silvery, or on occasion iridescent effects.

Skeletal System

The skeleton of a fish may consist of actual bones, as is true with the marine herring in which ossification is nearly complete, or it may be cartilaginous as in the sharks and rays. The major divisions of the skeleton may be listed as: the central vertebral column or backbone with its associated structures, the ribs, the median or unpaired fins, and the terminal tail; the girdles (pectoral and pelvic) and the attached paired fins; the skull, including the supporting structure of the operculum or gill cover. So numerous are the bones and so complicated is the skeletal structure that a detailed description here is entirely out of the question. This point is well illustrated by Figure 2 in which the principal bones of the smallmouth bass are named.

The usefulness of the skeleton does not end with its service as a scaffold supporting the body. It functions also in a protective capacity (witness the protection afforded the brain by the cranium and the spinal cord by the vertebrae), offers surfaces for the attachment of muscles, and provides leverage for movements. Because of the supporting effect of the water the two last-named functions are of notably less significance among fishes than among terrestrial vertebrates. Water offers sufficient resistance to sinking that locomotion can be accomplished readily by lateral strokes of the tail. The fish has no need for the intricate system of levers represented by the legs and wings of the higher vertebrates.

Musculature

The absence of such complicated appendages as the legs and wings of the terrestrial vertebrates makes it possible for fishes to maintain to a large extent the primitive condition in which the muscles of the body are arranged regularly down each side in a series of definite and similar segments. In most fishes these vertical segments are divided into dorsal (upper) and ventral (lower) sections by the lateral line. Fishes also have numerous specialized muscles such as those concerned with the movement of the jaws, operculum, and fins. Mention should be made also of the "smooth" muscles that are essentially parts of certain organs (as, for example, the wall of the digestive tract)

and of cardiac muscles of the heart and certain major blood vessels.

A most interesting specialization of muscle tissue is found in the electric organs of certain eels and rays, which are capable of imparting a shock sufficiently strong to knock down a full-grown man.

Respiration

In most fishes respiration takes place entirely by means of gills. (Figure 3 shows the gills and various internal organs of the green sunfish.) Each of the gill filaments, which are attached to the outer curve of the gill arches, is richly supplied with blood vessels. As water passes over the gills, carbon dioxide and other wastes are discharged from the blood and oxygen dissolved in the water is absorbed into the blood stream through the delicate membrane of the filaments.

The swim-bladder which is believed by students of evolution to have been developed originally as an organ of respiration still retains that function in certain relatively primitive fishes such as the lungfish, gar pike, and bowfin. The swim-bladder in most fishes (it is not present in all species) serves principally, however, as an organ for the maintenance of hydrostatic equilibrium between the fish and its environment.

Nervous System

In comparison with the higher vertebrates the nervous system of the fish must be considered poorly developed. The brain is extremely small in relation to the size of the body—too small indeed even to fill the tiny cranial cavity allotted to it. The lack of "gray matter" is especially appalling in the bony fishes (of which the herring is one), for in that group the cerebrum, traditional center of thought and reason, is almost totally lacking. Poor development extends also to the nerves which are relatively few.

Circulation

In the higher vertebrates two chambers of the heart (one auricle and one ventricle) are concerned with pumping the blood from the heart to the lungs and two with the distribution of the oxygenated blood to the various parts of the body. Since the fish's blood undertakes no "side trips," these animals are able to get along with a single auricle and a single ventricle.

The blood of a fish is pumped forward from the heart to the base of the gills, passes through the capillaries of the gill filaments, and is then distributed to the body tissues through arteries and capillaries. Blood collected by other capillaries returns to the heart through veins, directly or by way of the renal (kidney) or hepatic (liver) portal system.

Digestive Tract

The digestive system consists of major organs as in the higher vertebrates, namely, the mouth, gullet, stomach, intestines, pancreas, and liver.

The size and position of the mouth vary widely with the feeding habits of the fish. In bottom-feeding forms (as the suckers) the mouth may be turned downward. When the principal foods are found in the open water (as with the herring), the mouth usually is terminal. The structure and distribution of the teeth also vary with feeding habits. Predatory fishes ordinarily are equipped with numerous strong, sharp teeth on the jaws and in other parts of the mouth and pharynx as well. In other species teeth may be shaped for crushing or grinding or may be lacking altogether.

The collection of food is assisted in some species by the gill rakers (attached to the inside curve of the gill arches), which are so modified as to constitute a comb-like structure that strains small particles from the water.

The remainder of the alimentary tract offers few features that call for comment here. Mention should be made, however, of the pyloric caeca, tube-like sacs attached to the stomach near its exit. Their exact function is not known. These structures may be lacking entirely in some fishes (for example, the northern pike) or may number nearly two hundred (mackerel).

Excretory System

With respect both to position in the evolutionary sequence of vertebrates and to general complexity of structure, the kidneys of fishes may be termed intermediate. Anatomically, they appear as a pair of dark red elongate organs situated immediately below the vertebral column. The internal structure is such that numerous minute tubules are in sufficiently close contact with the blood to permit the extraction of waste

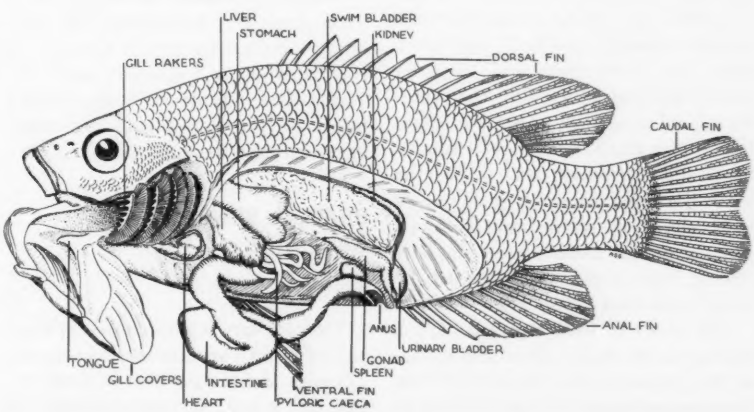


Figure 3.—Dissection of the green sunfish, *Lepomis cyanellus*, **showing internal organs. Modified drawing after Kellogg by Mrs. Ann S. Green.**

products. These tubules empty into paired excretory ducts which run along the entire length of the kidneys and then join to form a common avenue of drainage. Enlargements of the urinary ducts near their hinder end form bladders of various shapes.

The fish's kidney is not a perfectly efficient organ, for, as we have seen, waste materials are deposited in the skin in quantities large enough to have a profound effect on the color.

Reproduction

The ovaries (one or more commonly two) of female fishes lie in the upper part of the body cavity, more or less parallel to the kidneys. In most fishes the eggs are first discharged into a hollow central cavity of the ovary and then passed to the exterior through special ducts. Among certain fishes in which the young are born alive (many sharks), the terminal portion of these ducts may be expanded to supply accommodations for the developing offspring. In other viviparous fishes (as the mosquito fish) development of the young takes place within the ovary itself.

The number and size of eggs vary enormously according to the nature of reproductive habits. Egg production is highest among pelagic fishes that spawn in the open sea; an extreme example of high fecundity is provided by a ling that was found to contain more than 28 million eggs. The herring, although itself a pelagic spawner, produces eggs on a much less pretentious scale—usually within the range of 21-47 thousand. Nest builders as a rule produce substantially fewer eggs than do "wild spawners," and in viviparous species the number may be extremely small (only 4 to 14 eggs per season in one of the rays). Eggs of pelagic fishes are of necessity minute, but in some sharks they may be larger even than ostrich eggs.

The testes of male fishes occupy a position in the body comparable to that of the ovaries of the females and like them are provided with special ducts to lead the sex products from the body. Males of viviparous species are equipped with special organs (developed from the pelvic or anal fins) to facilitate internal fertilization of the eggs.

The size of the reproductive glands exhibits a tremendous increase as spawning approaches (especially the ovaries which in extreme cases can make up 25 to 30 percent of the body weight). At other periods, however, the ovaries and testes may be so small as to make determination of sex impossible without microscopic examination.

Anatomical Miscellany

It should be emphasized again that the space available here offers scant opportunity for delving into the minutiae of piscine architecture. The descriptive accounts of the preceding pages have been unavoidably more or less perfunctory. Only here and there has it been possible to indicate the enormous range of variation of anatomical structure or to detail one of the myriad fascinating specializations. Furthermore, certain organs and organ systems have been neglected *in toto*. Nothing was said, for example, of the lymphatic system with its lymphatic hearts and "glandular" spleen. Disregarded too have been other organs with which the fish could not well dispense—the red gland of the swim bladder, the thyroid, the thymus, the suprarenal bodies,....

To a certain degree the deficiencies of these pages are alleviated by the three figures illustrating certain features of the external and internal anatomy. Those who may desire more detailed information should consult the references given at the end of this leaflet.

SPECIAL SENSES OF FISHES

Smell

The olfactory organs consist of deep pits lined with special sensitive tissue. The size and the position of these organs on the head vary rather widely. In some fishes the sense of smell is extremely acute. Sharks, for example, are attracted from great distances by the smell of blood or of decaying flesh. The extent to which the olfactory sense is employed for the location of food varies not only with species but also with circumstances. Experiments conducted in England showed, for example, that pollock which were not very hungry regularly smelled food before taking it, but that when they were ravenous they readily bolted down clams soaked in such obnoxious substances as turpentine or chloroform.

Sight

The general structure of the fish's eye is similar to that of other vertebrates. There are, however, certain modifications for seeing under water. The outer wall of the eye is flatter in fishes than in land vertebrates. The lens, on the contrary, is much more rounded (in fact, is almost spherical) in fishes. Fishes focus their eyes, not by changing the shape of the lens as do terrestrial vertebrates, but rather by shifting its position. There is good evidence that fishes are relatively nearsighted. Experiments have proved also that they are capable of distinguishing colors. Eyes tend to be small and inefficient in species that live regularly in turbid water, and may be entirely lacking in fishes that inhabit underground waters.

Hearing

In fishes as in other vertebrates, the ear is an organ both of equilibrium and of hearing. An important difference, however, lies in the fact that fishes lack the external and middle ear of higher forms. The sense of balance is located in the three semicircular canals. That portion of the ear concerned with hearing lacks the intricate internal structure to be found in higher vertebrates. This fact, together with experimental evidence, has given rise to doubt as to whether fishes hear at all in the ordinary sense. It seems probable that their "hearing" consists of little if anything more than the detection of vibrations in the water.

In many fishes the ear is connected

with the swim-bladder by a tube-like outgrowth from the latter organ or by a series of small bones. It is considered possible that this arrangement intensifies the impulses from vibrations in the water.

Yet another structure that may "assist" the ear is the lateral line organ which on the basis of experimentation is believed capable of detecting low-frequency vibrations (in the neighborhood of six per second).

Taste

Almost nothing is known about the sense of taste in fishes. In fact, there is considerable question—for most species, at least—as to whether this sense actually is present. Many of the functions of taste are performed by special organs distributed over the body or on barbels. (See next section.)

Touch

This is probably the most highly developed sense of fishes. Sense organs in the form of buds or small pits and in contact with nerves are distributed over the entire body. They are especially numerous, however, in such strategic locations as the surface of barbels and feelers. In many bottom-dwelling forms the highly sensitive barbels perform indispensable service in the search for food.

The question as to the extent to which fishes feel pain has long been a subject for debate. Although we shall never know exactly how a fish feels when it is hooked, there is ample evidence that the experience is not sufficiently upsetting to cause even a halt to feeding activities. It is not at all uncommon for fishes that have escaped before being landed or have been released upon capture to take the hook again immediately afterwards.

SOURCES OF INFORMATION ON THE STRUCTURE AND SENSES OF FISH

No listing of technical publications on the anatomy and senses of fishes will be attempted here. Those interested can secure considerable information from various college textbooks.

J.R. Norman's *A History of Fishes* (A.A. Wyn, New York, 1948) is a veritable storehouse of facts on fishes.

A publication that contains a wealth of information on both the anatomy and senses of fishes is the two-volume work, *The Physiology of Fishes*, edited by Margaret E. Brown (Academic Press, New York, 1957.)

More recently there has appeared *Ichthyology*, by Karl F. Lagler, John E. Bardach, and Robert R. Miller (John Wiley and Sons, 1962). This comprehensive publication also carries excellent references.

MFR Paper 986. The paper above is from Marine Fisheries Review, *Vol. 35, Nos. 5-6. Reprints of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

Value Up, Volume Down in 1972 U.S. Landings

Preliminary data indicate that commercial fishery landings in the United States in 1972 were worth about $704 million to the fishermen, up 9 percent over the 1971 value of $643 million. This catch sold for an estimated $2.1 billion at retail. The volume landed in 1972 is expected to total 4.7 billion pounds, a 6 percent decline from 1971 landings of 5 billion pounds, but still 5 percent above the annual average landings for the previous five years.

Total commercial fishery landings by U.S. craft at ports outside the United States were 183.7 million pounds valued at $61.9 million in 1972. Tuna landings by U.S. fishing vessels in Puerto Rico and American Samoa accounted for four-fifths of the total quantity and half of the total value; shrimp and spiny lobster landings at Central and South American ports accounted for the remainder.

SAN PEDRO STILL LEADING PORT

San Pedro, Calif., remained the leading port in value of landings, and moved into first place in volume, supplanting Cameron, La., which slipped to second. Tuna is the primary species landed at San Pedro, while menhaden, a fish used for industrial purposes such as fishmeal, accounts for most of the landings at Cameron.

Values of the landings at various U.S. ports were:

	million dollars
San Pedro, Calif.	59.0
Brownsville-Port Isabel, Tex.	28.5
Aransas Pass, Rockport, Tex.	21.9
New Bedford, Mass.	18.3
San Diego, Calif.	15.9
Kodiak, Alaska	15.3
Freeport, Tex.	15.2
Dulac-Chauvin, La.	14.0
Bayou La Batre, Ala.	13.6
Cameron, La.	11.2

The port rankings by volume in 1972 were:

	million pounds
San Pedro, Calif.	452.4
Cameron, La.	394.5
Pascagoula-Moss Point, Miss.	205.0
Dulac-Chauvin, La.	183.0
Empire, La.	134.0
Morgan City, La.	128.6
Kodiak, Alaska	119.1
Gloucester, Mass.	113.3
San Diego, Calif.	72.1
New Bedford, Mass.	60.2

CONSUMPTION UP

The 1972 data shows that Americans are eating more fish. In 1972, the per capita consumption of fishery products was 12.2 pounds per person. In 1971, the per capita consumption was 11.4 pounds.

The 1972 consumption figure ties the record U.S. figure set 45 years ago, in 1927. It shows that the American housewife was buying more fish for her family months before meat prices became headline news early in 1973.

The 12.2-pound figure includes purchases of edible fish of all types, fresh, frozen, canned, etc., for which statistics are compiled. Consumption of canned fishery products was 4.9 pounds per person in 1972, up from 4.3 a year earlier. Canned tuna increased from 2.4 pounds per person to 2.9. Shrimp showed a slight increase at just over 1.4 pounds per person.

The Fisheries Service reports that additional supplies of fish were available at least in part, because of a 24 percent increase in imports of fresh and frozen fillets, steaks, and fish blocks, and a 40 percent increase in the U.S. production of canned tuna.

NMFS publishes data on fish and fisheries in its annual publication, "Fisheries of the United States," the 1972 edition of which is expected from the publisher soon. It is available from Government Printing Office Book Stores for $1.00 per copy or by mail from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.25 per copy. The publication is also known as "Current Fisheries Statistics No. 6100."

Source: U.S. Department of Commerce News, NOAA 73-87 and NOAA 73-93.

Roedel to Coordinate Marine Recreation Programs

The Commerce Department's National Oceanic and Atmospheric Administration (NOAA) announced May 2, 1973, establishment of the position of Coordinator of Marine Recreation Programs, designed to help support the nation's ever-growing marine leisure activities.

The position, on the staff of NOAA's Associate Administrator for Marine Resources, has been assumed by Philip M. Roedel, who left the Directorship of the National Marine Fisheries Service (NMFS) to inaugurate the program. Pending appointment of an NMFS Director, Robert Schoning, Deputy Director, is serving on an acting basis.

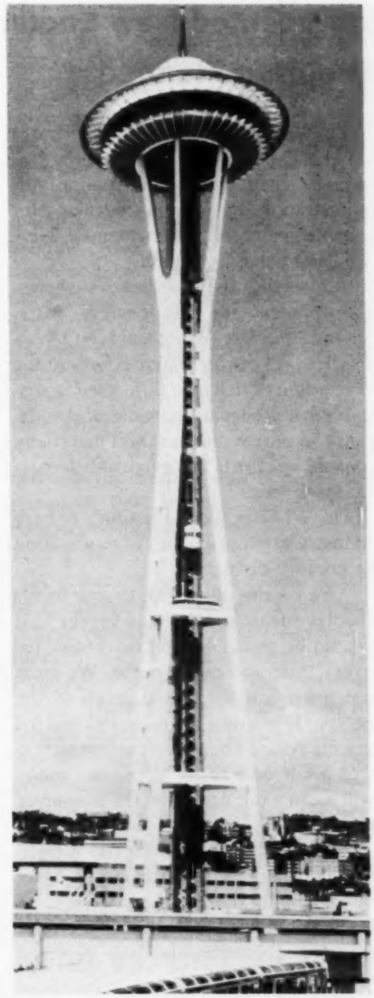
The new post has broad responsibility across every NOAA agency involved in marine recreation. Accepting the position, Roedel said:

"Marine recreational activities, such as sport fishing and boating, now constitute or generate a major fraction of the economic activity associated with the marine environment. More and more, they offer a way for many millions of Americans to have the fullest enjoyment of that environment."

Roedel has served as Director of NMFS since its establishment as a major NOAA agency in October 1970. In January of that year he became director of the NMFS predecessor, the Bureau of Commercial Fisheries.

Source: U.S. Dept. of Commerce News, NOAA 73-94.

NOAA Sponsors Seattle Meeting on "The Oceans and Economic Development"



The Space Needle, symbol of Seattle. Photograph by courtesy of the Seattle-King County Convention and Visitors Bureau.

Secretary of Agriculture Earl L. Butz, Secretary of the Interior Rogers Morton, and Secretary of Commerce Frederick B. Dent will head the list of Federal Government officials who will participate in a conference on "The Oceans and National Economic Development" in Seattle, Wash., July 17-19.

The three-day meeting is sponsored by Commerce's National Oceanic and Atmospheric Administration.

Secretary Butz will give the keynote address, entitled "Our National Ocean Goals," at the conference, which is aimed at planning the future of the nation's oceanographic effort during the balance of the 20th century.

Others slated to participate in the conference include Dr. Robert M. White, Administrator of NOAA; Dr. Betsy Ancker-Johnson, Assistant Secretary of Commerce for Science and Technology; and Robert J. Blackwell, Assistant Secretary of Commerce for Maritime Affairs.

The participants will serve both as speakers and panelists, and will be joined by a wide variety of industrial, scientific, technical and conservation interests. Conferees will be encouraged to pool their views and take a fresh look at the ocean's potential for meeting national economic and social needs during the next quarter century.

The purpose of the conference will be outlined by Dr. White, the NOAA Administrator, when the meeting convenes July 17 after welcoming speeches by Governor Daniel J. Evans of Washington and Mayor Wesley C. Uhlman of Seattle.

INDUSTRY LEADERS TO ATTEND

Leaders in American industry with a stake in oceanography will also play a key role in the conference.

Representing the shipping and fishing industries will be James Reynolds, President, American Institute of Merchant Shipping (and his labor counterpart, O. William Moody, Administrator, AFL-CIO Maritime Trades Department); Frank Holas, President, Booth Fish Co., Chicago; Harold Lokken, Manager, Fishing Vessel Owners Association, Seattle; and Richard Stroud, Executive Vice President, Sport Fishing Institute, Washington, D.C.

Present also for the conference, in addition to industry representatives, will be important members of Congress, including Senators Warren G. Magnuson and Henry Jackson of Washington; Ernest F. Hollings of South Carolina; Ted Stevens of Alaska; and Mark O. Hatfield of Oregon; and Representatives Charles A. Mosher of Ohio and Joel Pritchard of Washington.

Representatives of environmental groups from the United States and Canada will also address the conference.

PROGRAM ORGANIZATION

The first day will open with distinguished speakers, including the keynote address. To organize the six principal areas of interest for the three days of the conference, the program has been broken into six primary sessions:

(1) The Ocean's Energy and Mineral Resources

(2) The Ocean's Living Resources

(3) The Oceans as a Recreational Resource

(4) Coastal Zone Management and Marine Resource Development

(5) Regional Organizations and Economic Development of Marine Resources

(6) Marine Transportation's Role in Meeting Energy Needs.

The program of the conference was developed by NOAA with the assistance and recommendations of senior representatives of the following organizations: National Advisory Committee on Oceans and Atmosphere, National Science Foundation, Office of the Oceanographer of the Navy, Maritime Administration, National Industrial Association, SEA USE Council, Marine Technology Society, and the Seattle-King County Economic Development Council.

Sources: U.S. Dept. of Commerce News, NOAA, various releases.

Augmented New England Fishery Program Planned

Dr. Robert M. White, Administrator of the Commerce Department's National Oceanic and Atmospheric Administration, has announced plans for establishment of an augmented New England fishery program.

Addressing the Northeast Fisheries Conference in Gloucester, Massachusetts, Dr. White said NOAA's NMFS will devote major efforts to the promotion of fish now little-used or discarded; will provide technological assistance in processing; and will materially expand its efforts in foreign and domestic marketing.

Dr. White urged the nation's fishery industry to adopt a policy of moderation in pricing, saying:

"We cannot allow fish to lose its attractiveness to the consumer...it should be available, and marketed, for every taste and every purse. We must not price fish out of the reach of the people. It is a time for restraint, and for pricing policies based on the conviction that a fair deal to the consumer today will mean a fair deal from the consumer tomorrow."

Although the demand for fish is high, he said, industry nevertheless is beset by such fundamental problems as foreign competition, high costs, erratic markets, contaminants, and depleted stocks.

Dr. White pledged a vigorous effort by the Federal government to overcome these problems and declared that solutions can come only when Federal and state governments and industry, all with common objectives, combine to attack them.

The government is determined to acquire control of coastal species in the high seas off our shore for American fishermen, through the forthcoming Law of the Sea Conference. He said: "The day is gone when we will accept just any arrangement. We shall insist upon what we need, and we shall stay with it."

Dr. White revealed that, although enforcement and surveillance programs directed at foreign fishermen have tripled in the Atlantic over the past five years, they will be expanded further in the coming year, with the help of the U.S. Coast Guard.

He counseled rapid action to establish Federal-State cooperation for specific species of fish: at present no Federal authority exists to exercise management within the contiguous zone between 3 and 12 miles, and no general authority beyond 12 miles.

"President Nixon," he said, "has highlighted the importance he attaches to this matter; as a result, the High Seas Conservation Act has been introduced and awaits Congressional hearing this month." He urged support for its passage.

Dr. White predicted that if presently contemplated Federal efforts are successful, "we will have established a basic structure in which the industry can thrive and the fisheries resource be conserved for generations to come. If we can achieve this, it will constitute an historic step forward."

Source: U.S. Dep. of Commerce News, NOAA 73-95.

PROPOSED SALMONELLA INSPECTION PROGRAM

An announcement, published in the May 11, 1973, "Federal Register," stated that, the National Marine Fisheries Service, U.S. Department of Commerce, has received several requests from members of the fishmeal industry and the National Fishmeal and Oil Association to design and operate a Salmonella inspection program for fishmeal plants and products. They further requested that the program incorporate the use of manufacturing guidelines, as well as practices and procedures that have been developed and approved, cooperatively, by NMFS, USDA, FDA, and State agencies.

As it has been the policy of NMFS to assist the fishmeal producing industry in developing and applying sanitation guidelines for the control of Salmonella in fishmeal plants and products, NMFS now intends to formally make inspection services available for this purpose. The program will be generally modeled along the lines suggested by the industry, and known by the cooperating agencies to be effective for control of Salmonella.

The NMFS "Inspection Program for Fishmeal Plants and Products" will be made available to interested participants through contractual arrangements on a fee for service basis, and charges shall be in accordance with those fees and charges detailed in part 260, title 50, Code to Federal Regulations. Inspection and certification services also will be available on a lot basis.

Potential applicants interested in participating in the proposed program are invited to write to the Director, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C. 20235.

Sportfisheries Expert Retires

One of the country's most respected authorities on sport fisheries, wildlife, and conservation, John S. Gottschalk, retired in April after 28 years in Government service. For the past two and one-half years, he had served NMFS as Assistant for Sport Fisheries to the Director. Before that, the 60-year-old scientist spent 25 years with the Interior Department's Bureau of Sport Fisheries and Wildlife, the last six as Director.

Mr. Gottschalk has accepted the position of Executive Vice President of the International Association of Game, Fish and Conservation Commissioners, an organization with offices in Washington, D.C., primarily serving the interests of State and Canadian Provincial fish and game agencies.

Japan: Canned Tuna under New Prices; Frozen and Canned Exports Decline; New Ventures Formed

TRIAL SALES OF CANNED TUNA TRIED AT NEW PRICES

The Tokyo Canned Tuna Sales Company (representing packers) on May 4, 1973 conducted trial sales of about 51,000 cases of canned tuna in brine for export to the United States under new prices. Four can sizes were offered from among the stocks carried over from the previous year's production. (Note: This is the first time the Sales Company has offered canned tuna since the second U.S. dollar devaluation and yen flotation.) The sales prices for all can sizes have been reduced from the pre-float quotations. Closing date for the sales was to be May 10, with shipments to be made within 45 days from the date of contract with trading firms. Attention is being focused on the sales since the prices for some can sizes will be higher in US dollars than before because of the upward float of the yen. ("Kanzume Joho," May 8, 1973.)

New Prices of Canned Tuna in Brine for Exports to U.S.

Can Size	Price per Case[1] New Price Yen	New Price US$[2]	Old Price Yen	Old Price US$[3]
SOLID:				
Light Meat:				
7-oz. 48's	4,050	15.23	4,450	14.83
13-oz. 24's	4,000	15.04	4,350	14.50
66½-oz. 6's	4,400	16.54	5,270	17.57
CHUNK:				
White meat:				
66½-oz. 6's	6,000	22.56	6,300	21.00
Light meat:				
66½-oz 6's	4,100	15.41	5,000	16.67

[1]Ex-warehouse, Shimizu, Japan.
[2]Based on current floating rate of 266 yen equal one US dollar.
[3]Based on 300 yen equal one US dollar.

FROZEN AND CANNED FISHERY EXPORTS DECLINE

Japanese frozen and canned fishery exports during January-March 1973, based on customs clearance data, declined for most of the products as compared with the first quarter of 1972. Fresh and frozen tuna exports were down about 20 percent from the comparable 1972 period. Among the canned products, tuna, salmon, and crab all recorded a decline ("Suisan Tsushin," May 4, 1973.)

NEW FISHERY VENTURES FORMED

The Japanese fish net manufacturer Nichimo and two New Zealand firms, J.B.L. Seafood Company and the Development Finance Corporation (DFC) on May 1, 1973 formed a joint fish processing venture. The joint company, named Jaybell (phonetic)-Nichimo, with head office to be located in Auckland, will be organized with a capital of NZ$1.3 million, to be contributed 24.9 percent by Nichimo, 25.2 percent by D.F.C. and 49.9 percent by J.B.L. Seafoods. The new company will engage in buying and processing fish and shellfish as well as in selling Nichimo's fish nets and other fish and vessel supplies. Fishery products will be exported primarily to the United States, Japan and Australia. Exports to Japan, mostly frozen sea bream and hardtail, are expected to reach 2,000 tons annually with a value of about 600 million yen (US$2.26 million, based on current floating rate of 266:1). ("Suisan Tsushin," May 8, 1973.)

The Japanese fishery firms Taiyo and Nippon Hogei and one trading firm, Mitsubishi Shoji, are shortly forming a joint fishing and processing venture in Peru in partnership with the Peruvian Fishery Public Corporation (EPSEP). A formal agreement was scheduled to be signed in Tokyo May 13 between the Japanese and the Peruvian EPSEP's President Juillermo Arbur, who was expected to arrive in Japan shortly. The new company, to be named Chalwa del Peru, S.A. ("Chalwa" is phonetic spelling), is to be financed 33 percent each by Taiyo-Nippon Hogei group and Mitsubishi, and 34 percent by EPSEP. In three years the invested capital is expected to total US$10 million. The joint company will engage in fishing for merluza (hake) and shrimp, fish processing, manufacture of fish-ham sausages and canning. Most of the processed products will be exported to the United States, European countries and Japan. The Peruvian corporation's tie-up with the Japanese is believed to be aimed at utilizing Japanese fishing and processing technology to diversify the Peruvian fishery industry, which is based primarily on a single species, anchoveta, the catch of which sharply declined in 1972 because of abnormal oceanic conditions. ("Suisan Tsushin," May 2, 1973.)

A group of Japanese businessmen have offered to enter into a joint eel culture venture in the Philippines with a local firm, the Government of the Philippines announced. The business group, from Showa Denko, one of Japan's largest chemical plants, and the Apollo Trading Company, made the proposal. President Ferdinand Marcos endorsed their request to the Department of Agriculture and Natural Resources. The two Japanese companies have been conducting research on eel production in the Cagayan Valley, north of Manila, for the last three years and they were confident they could place eels grown here on the world market. (AFP Manila dispatch carried in "The Mainichi," April 6, 1973.)

Source: Summarized from the Japanese press by James H. Shohara, Translator, NMFS Division of Foreign Reporting.

PERU NATIONALIZES FISHMEAL INDUSTRY

Peruvian Fisheries Minister Javier Tantaleon, on May 8, 1973, announced that Peru's fishmeal industry would be nationalized. The decision to nationalize the industry was apparently

based on two factors: (1) the precarious state of the anchovy stocks, and (2) the growing indebtedness of the industry. Reportedly, the decision to nationalize the industry came as no surprise to knowledgeable sources.

The move is said to affect some 27,000 fishermen, 1,486 vessels and 105 plants.

Peru, at one time, supplied nearly 45 percent of the world's fishmeal and has been the world's most productive fishing nation in terms of catch.

Five United States firms have sizable investments in the fishmeal industry in Peru; total U.S. investment in that nation's fishery is believed to be around $40 million.

India's Seafood Exports Up in 1972

India's seafood exports were 38,271 metric tons valued at US$75.4 million in 1972.[1] During the previous year, exports totaled 34,032 tons valued at $50.8 million. The increased value of India's seafood exports was largely due to the increasing world price for frozen shrimp. Other seafood exports included lobster tails, frog legs, canned shrimp and fish, dried fish and shrimp, and other fish products. The growth of India's seafood export industry is shown in Table 1. Its dollar value has increased tenfold in a decade.

Table 1.—India's seafood exports, 1963-72.

Year	Quantity	Value
	Metric tons	*US$1 million*
1972	38,271	75.4
1971	34,032	50.8
1970	37,175	46.1
1969	30,584	42.9
1968	24,810	28.6
1967	21,764	25.8
1966	19,153	17.5
1965	15,457	8.9
1964	21,458	8.8
1963	17,908	7.6

SHRIMP EXPORTS

The leading export commodity, as in previous years, was shrimp. In 1972 India exported 30,550 tons of frozen shrimp worth $66.0 million. In 1971 shrimp exports were 23,181 tons valued at $40.6 million. Frozen shrimp now ranks as one of India's ten most valuable export commodities. The development of India's shrimp exports is shown in Figure 1.

[1]Based on 770 Rupees = US$1.00

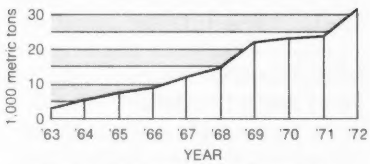


Figure 1.—India's shrimp exports, 1963-72.

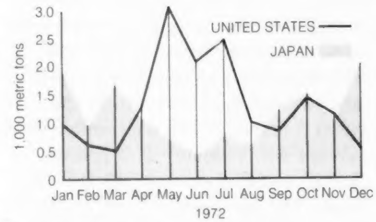


Figure 2.—United States and Japanese imports of frozen shrimp from India, by month, 1972.

In 1972, the United States imported 15,227 tons (versus 10,350 tons in 1971) of frozen Indian shrimp valued at $27 million (against $13.5 million in 1971).[2] Japan, which closely rivals the United States as India's largest customer, increased its purchases to 12,811 tons (versus 9,703 tons in 1971) valued at $39.9 million (versus $23.6 million in 1971)[3]. Heavy imports of less valuable, smaller-sized (over 80-count), P&D shrimp, by American importers accounted for the difference in value. The Japanese imported medium- to large-sized shrimp and paid a correspondingly higher price for their purchases. A comparison of U.S. and Japanese shrimp imports from India in 1972 is shown in Figure 2.

[2]Based on U.S. import statistics.
[3]Based on Japanese import statistics.

In spite of increased sales, 1972 was a complicated year for Indian exporters. The Japanese, for example, purchased less shrimp than Indian traders had expected. The Japanese, who purchased very large quantities in late 1971, were heavily stockpiled and the market in Japan did not firm until the last quarter when imports increased. Also, increased world shrimp production —Indonesia replaced India as Japan's largest supply source in 1972—affected the demand for Indian shrimp. At the same time, rising world prices for shrimp apparently began meeting consumer resistance. In the U.S. market, for example, Indian shrimp is largely purchased by a fairly small number of processors who, viewing the uncertainties of the American market, purchased less shrimp than they might have in a strong market. Several Indian traders, anticipating strong world demand and increased prices, apparently misjudged in their purchases and were forced to suspend business.

There were additional problems affecting the Indian shrimp industry in 1972. The lack of refrigerated carriers traveling to Europe, where Indian seafoods are becoming increasingly more popular, was one problem. The Indian industry believes this causes overreliance on traditional markets. Finding reliable freight routes to new markets continues to be a major item of concern in India.

There was a sharp decrease in shrimp production in Kerala where the Indian shrimp industry was born. In 1971, fishermen in Kerala produced 85 percent of India's shrimp; in 1972 that figure had dropped to 67 percent. Indian sources believe that offshore and deepsea stocks of shrimp may provide a solution to this problem, but are still openly concerned by this adverse development.

Fishing on the east coast of India, where virgin stocks abound, has begun, but friction between artisanal fishermen and trawlers has been reported. The lack of an infrastructure to meet the needs of the shrimp export industry is

also hindering the progress of this fishery.

Problems involving financing, which have forced some exporters to suspend activities, have also upset the industry, but seafood dealers see signs that local bankers are taking another look at the industry.

Finally, the establishment of the Marine Products Export Development Authority is seen as a move which may cause some initial hardships, but which the industry feels will have a long-range beneficial impact on the country's shrimp exports.

OTHER EXPORTS

The canning and dried seafoods industry apparently suffered from severe setbacks in 1972, with exports declining. The dried fish and prawn industry were reportedly the hardest hit. There were no explanations for these setbacks. ("Seafood Export Journal," Annual, January 1973 and other sources.)

Prepared by NMFS International Activities Staff.

Letters[1]

Status of FPC in U.S.

Robert W. Schoning
Acting Director, NMFS

...would you...ask someone on your staff to forward me an up-to-date report on the status of FPC in the U.S.A. if one is available...

Hugh Munro
566 Minette Circle
Mississauga, Ontario
Canada

Regarding the present status of FPC in the U.S., a decision was made recently to terminate the National Marine Fisheries Service's 12-year FPC research and development program. This was due in part to the overall budget cutbacks experienced by our Agency, as well as the expiration of the FPC Act (PL-89-701, as amended) on June 30, 1972.

Plans are being developed to dispose of the Experiment and Demonstration Plant in Aberdeen, Washington, and the limited quantities of product remaining from its operation. We are also currently compiling information so as to provide as complete an information package as can be developed for anyone generally interested in FPC or considering its commercial development. This will make available all information generated by our activities over the past years, as well as a detailed discussion of the state-of-the-art and a description of the remaining unresolved problems. This information package will be put on microfilm and its availability publicized. If you would be interested in obtaining a copy, please write:

Dr. George Knobl
Director
College Park Fishery
Products Technology Laboratory
Regents Drive
College Park, Maryland 20740

It should be available in 2-3 months.

Limited domestic interest in FPC within the industry appears to be continuing, based upon our contacts, as well as the number of requests for samples of the product produced in Aberdeen. However, until the one pound packaging restriction presently in the U.S. Food and Drug Administration (FDA) regulations is removed, the emergence of a domestic industry is unlikely. A petition to remove this restriction is presently being considered by FDA and a favorable disposition is expected shortly.

Regarding international interest in FPC, I suggest you write Dr. Steve R. Tannenbaum at the following address and request a copy of the proceedings from an international conference on FPC held in Cambridge in June 1972.

Dr. Steve R. Tannenbaum
Associate Professor of
Food Science
Department of Nutrition
and Food Science
Massachusetts Institute of
Technology
Cambridge, Massachusetts 02139

This will give you a summary of both the interest and activities of the many countries represented at the conference.

Joseph W. Slavin
Associate Director for
Resource Utilization

[1]Editor's Note: The plural here is an optimistic misnomer, since we have only one letter. But it deals with an important topic. We would like to use this space to print answers by NMFS specialists to fishery questions of general interest. If you have such a question, please address it to the Editor, *Marine Fisheries Review*, Room 450, 1107 N.E. 45th St., Seattle, WA 98105. We reserve the right to edit letters.

Publications

"Our Living Oceans"

A new NMFS publication series, "Our Living Oceans," developed jointly by the NOAA Publications Office and the Extension Division, has been established. The first number issued is "Secrets of the Sea."

The series is primarily oriented toward educational user groups, ages 8 to 18. Much of the information, however, should also be useful to anyone interested in living marine resources.

Copies of "Our Living Oceans" are available from NMFS Regional Coordinators. Additional copies are also available from D83, Technical Information Division, Environmental Data Service, NOAA, Washington, DC 20235.

"Hawaiian Reef Animals"

NMFS scientist Edmund Hobson is co-author of a new book, "Hawaiian Reef Animals," published by the University of Hawaii Press with support in part from the State of Hawaii and from NOAA's Sea Grant Program. Dr. Hobson wrote the introduction and the section on fishes. E.H. Chave, University of Hawaii, contributed a section on invertebrates.

The book is illustrated with 86 superb full-color photographs of the fishes and invertebrates. These were all taken by Hobson, a skillful diver and photographer of professional ability.

Hobson received his doctorate from the University of California, Los Angeles. At present he is working at the Marine Science Center, Avalon,

California, on a study of fishes associated with California's kelp forests.

The 135-page book, "Hawaiian Reef Animals" is available for $7.50.

Marine Pollution

Five papers by NMFS scientists appear in the book, "Marine Pollution and Sea Life," issued by Fishing News (Books) Ltd., London (price 17 pounds, 45 pence). The book, the publishers say, deals with the most comprehensive effort ever made to scientifically assess, with a view to remedy, the extent of marine pollution throughout the world today and its effect on sea life. A congress of scientists in the areas concerned with pollution, and of administrators and executives associated with official and civic bodies, was organized by the Food and Agriculture Organization of the United Nations and held in Rome in 1970. The volume is one result of that conference.

NMFS authors and their papers are:

Rice, T.R., J.P. Baptist, F.A. Cross (all of the Atlantic Estuarine Fisheries Center, Beaufort, N.C.), and T.W. Duke (now of the Environmental Protection Agency, Gulf Breeze, Fla.), "Potential Hazards from Radioactive Pollution of the Estuary," p. 272-276.

Trent, W.L. (Gulf Coastal Fisheries Center, Panama City Laboratory, Fla.), E.J. Pullen (Corps of Engineers, Galveston, Tex.), and D. Moore (Water Resources Division, NMFS Southeast Region), "Waterfront Housing Developments: Their Effect on the Ecology of a Texas Estuarine Area," p. 411-417.

Stout, V.F. (Pacific Fishery Products Technology Center, Seattle, Wash.), F.L. Beezhold, and C.R. Houle (Pacific Fishery Products Technology Center, Seattle, Wash.), "DDT Residue Levels in Some U.S. Fishery Products and Some Treatments in Reducing Them," p. 550-553.

Glude, J.B. (Northwest Region, Seattle, Wash.), "Information Requirements for Rational Decision-Making in Control of Coastal and Estuarine Oil Pollution," p. 622-624.

Pearce, J.B. (Middle Atlantic Coastal Fisheries Center, Highlands, N.J.), "The Effects of Solid Waste Disposal on Benthic Communities in the New York Bight," p. 404-411.

Bioenvironmental Studies

A.T. Pruter, Deputy Director, Northwest Fisheries Center, Seattle, Wash., and D.L. Alverson, Director, Northwest Fisheries Center, are coeditors of an 882-page book, "The Columbia River Estuary and Adjacent Ocean Waters," published for the Atomic Energy Commission by the University of Washington Press (price, $22.00).

The book is based on research carried out by the University of Washington, Oregon State University, Battelle Memorial Institute, and NMFS. It describes the physical, chemical, and biological aspects of the Columbia River estuary and adjacent ocean waters, and measures radionuclides in the physical environment and the biota.

Paper by NMFS staff members (all from the Northwest Fisheries Center) are:

Pruter, A.T., "Review of the Commercial Fisheries in the Columbia River and in Contiguous Ocean Waters," p. 81-120.

Heyamoto, H. (with Andrew J. Carey, Jr., Oregon State University), "Techniques and Equipment for Sampling Benthic Organisms," p. 378-408.

Pereyra, Walter T., and Miles S. Alton, "Distribution and Relative Abundance of Invertebrates off the Northern Oregon Coast," p. 444-474.

Alton, Miles S., "Bathymetric Distribution of the Echinoderms off the Northern Oregon Coast," p. 475-637.

Pereyra, Walter T., "Bathymetric and Seasonal Abundance and General Ecology of the Tanner Crab, *Chionoecetes tanneri* Rathbun (Brachyura: Majidae), off the Northern Oregon Coast," p. 538-582.

Alton, Miles S., "Characteristics of the Demersal Fish Fauna Inhabiting the Outer Continental Shelf and Slope off the Northern Oregon Coast," p. 583-634.

Alverson, Dayton L., "Bioenvironmental Features: An Overview," p. 845-857.

Directories for Mariners

Directories of services for mariners covering Alaska, British Columbia, Washington, Oregon, California, and Hawaii have been issued in two publications sponsored by the Pacific Area Sea Grant Advisory Program (PASGAP).

PASGAP 1, "Directory of Services for Mariners: North Pacific Coast," a revision of "Commercial Fishermen's Directory of Emergency Services: North Pacific Coast," originally published in 1971, is a 158-page publication covering Alaska, British Columbia, Oregon, and northern California. It covers such topics as medical assistance available to fishing vessels; U.S. Public Health Service physicians and hospitals; Coast Guard stations; customs reminders; marine weather broadcasts; special broadcasts of warning message, and other topics. By port, it lists the names, addresses, and telephone numbers of agencies and businesses offering marine services and supplies.

PASGAP 8, "Directory of Services for Mariners: California and Hawaii," gives the same types of information for those states.

Both publications are available free from participating agencies.

PASGAP is a regional organization funded by NOAA's Office of Sea Grant. Its purpose is to identify regional marine needs and priorities and to fill these needs through publications, talent sharing, and workshops. Members include representatives of marine advisory programs from the University of Alaska, the University of British Columbia, University of California, University of Southern California, University of Hawaii, Oregon State University, University of Washington, and NMFS.

Russian Translations

The following six Russian publications were recently translated and printed in Israel for the National Marine Fisheries Service (NMFS), NOAA, under the Special Foreign Currency Science Information Program (financed with Public Law 480 funds). They are sold at the indicated prices by the National Technical Information Service (NTIS), Springfield, Va. 22151. When ordering, cite the publications' accession numbers.

1. "Soviet Fishery Investigations in the Northeastern Pacific," Part 5, edited by P.A. Moiseev, Proceedings of the All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Vol. 70, and (jointly) Proceedings of the Pacific Research Institute of Fisheries and Oceanography (PINRO), Vol. 72, Moscow, 1970, 462 pp.

This collection of 25 papers is the last part of a five-volume series covering the comprehensive fisheries research done by the Soviets in the eastern Bering Sea, Gulf of Alaska, and adjacent waters. The papers deal with the following topics related to those areas: bottom relief; sediment; areas suitable for trawling; mineral composition; hydrological characteristics of whaling grounds; and primary production and quantitative distribution of plankton and benthos. Also covered is the distribution of several species of crustaceans and fish such as the deep-sea prawn, king crab, squid, rockfish, halibut, yellowfin sole, herring and walleye pollock. Accession number: TT 71-50127. $10.60.

2. "Theory and Design of Commercial Fishing Gear," by A.L. Fridman, Moscow, 1969, 489 p.

This textbook was compiled for the training of students of Soviet fishery colleges and faculties. The general principles involved in commercial fishing gear and their application to the design of basic types of gear are discussed. In addition to presenting traditional methods for the evaluation and testing of fishing gear, several new methods based on the theory of similarity and modeling are described. The design of trawls, seines, stationary gear and hooks and lines are discussed at great length. Also covered is the gear utilized for fishing with electric light and electric current. Accession number: TT71-50129. $6.00.

3. "The Sperm Whale," by A.A. Berzin, Pacific Research Institute of Fisheries and Oceanography (PINRO), Moscow, 1971, 394 pp.

The material in this volume was collected by the author during whaling expeditions in North Pacific in 1955-1956 as well as during cruises of research vessels. Covered in great detail are the systematics, morphology, distribution and biological features of the sperm whale. Also discussed are commercial whaling and processing and utilization of the whale's raw material. Accession number: TT71-50152. $6.00.

4. "Fertilization in Fishes and the Problems of Polyspermy," by A.S. Ginzburg and published in Moscow in 1968.

The book is an extensive survey on fertilization patterns in relationship to polyspermy, especially pertaining to fishes. It describes in detail the organization and properties of fish eggs and spermatozoa, their interaction and changes during fertilization. A mechanism for protecting the egg from supernumerary spermatozoa is suggested. Factors determining change in types of fertilization (physiological monospermy and polyspermy) in evolution are also discussed. A useful supplement for fish culturists contains practical conclusions based on the presented data. Accession number: TT 71-50111. $6.00.

5. "Proceedings of the All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO)," Vol. 79, edited by A.S. Bogdanov and published in Moscow in 1971.

A collection of 25 papers covering a variety of problems related to fish resources; perfection of fish finding; and the technology and mechanization of fish processing. Specifically, they deal with aspects of research and biological resources of the world ocean (paper by P.A. Moiseev, Director of VNIRO); water dynamics in areas of krill concentrations; surface currents in the Scotia Sea; biological productivity of aquatic biocenoses and problems of chemical ecology; physiology of marine and anadromous fishes; regression analysis as a method of forecasting; effect of radioactive contamination of the aquatic medium on the reproduction capacity of fish; estimation on the number of fertile female harp seals; irradiation of fish under marine fishing conditions; krill as a food resource; new methods for the production of agaroid; and other papers on fish processing. Accession number: TT 71-50131. $3.00.

6. "Fauna of the Kurile-Kamchatka Trench and its Environment (Based on Data of the 39th Cruise of RV *Vityaz*)," edited by V.G. Bogorov and published in Moscow in 1970.

The extensive material collected during the numerous comprehensive trips of RV *Vityaz* has revealed general patterns in the distribution of animals and plants in the water as related to physical and chemical factors. The Kurile-Kamchatka Trench area in NW Pacific was selected for investigation because its maximum depths exceed 30,000 feet. It was thus possible to study the vertical changes of fauna within a wide range of depths. In addition, the high productivity of surface waters in this area is responsible for the presence of a rich deep-water fauna which increased the diversity of material obtained and yielded larger samples per unit time than less productive parts of the ocean. Accession number: TT 71-50130. $6.00.

Recent NMFS Scientific Publications

PERIODICALS

Fishery Bulletin, Vol. 71, No. 1, January 1973, p. 1-324. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Subscription price: $8.00 per year ($2.00 additional for foreign mailing). Cost per single issue, $2.25.

Marine Fisheries Abstracts. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Subscription price: $6.50 per year ($1.75 additional for foreign mailing). Single copy, 65 cents.

Vol. 26, No. 1, January 1973, 32 p.
Vol. 26, No. 2, February 1973, 32 p.
Vol. 26, No. 3, March 1973, 44 p.
Vol. 26, No. 4, April 1973, 30 p.
Vol. 26, No. 5, May 1973, 40 p.

Marine Fisheries Review. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Subscription price: $12.50 per year ($3.25 additional for foreign mailing). Single copy, $1.25.

Vol. 35, Nos. 1-2, January-February 1973, 56 p.

Vol. 35, Nos. 3-4, March-April 1973, 80 p.

OTHER PUBLICATIONS

NOAA Technical Report NMFS CIRC-368, McNulty, J. Kneeland, William N. Lindall, Jr., and James E. Sykes. **"Cooperative Gulf of Mexico estuarine inventory and study, Florida: phase 1, area description."** November 1972. 126 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: $1.25.

ABSTRACT

Newly-developed tables and maps depict the dimensions, submerged vegetation, tidal marshes, mangrove swamps, commercial oyster beds, leased oyster-rearing areas, sources of pollution, drained tidal marshes, and filled areas of Florida's west coast estuaries. Published and unpublished information on temperature, salinity, geology, artificial fishing reefs, stream discharge, human population, commercial fishing, and economic development is presented in new form.

If the total area of estuaries (3,003,312 acres = 1,215,440 ha) is considered to be the area of open water (2,081,525 acres = 842,393 ha) plus the area of mangrove swamps (393,160 acres = 159,112 ha) and tidal marshes (528,528 acres = 213,895 ha), then roughly one-half of the total area of estuaries is unvegetated; the remaining half is about equally divided among mangroves, tidal marshes, and submerged vegetation.

Human population in coastal counties increased from 614,616 persons in 1930 to 3,320,226 persons in 1970, resulting in adverse effects from pollution to 43 percent of estuarine areas, filling of 23,521 acres (9,519 ha) mainly for residential and industrial development, and draining of 26,676 acres (10,796 ha) of tidal marshes for mosquito control. Increasing population correlates directly with the number of sources of pollution, filled area, and the area closed to shellfishing by public health authorities; thus, failure to control the adverse effects of population growth will clearly result in continued rapid degradation of estuarine habitat on Florida's west coast.

NOAA Technical Report NMFS CIRC-369. Feddern, Henry A. **"Field guide to the angelfishes (Pomacanthidae) in the western Atlantic."** November 1972. 10 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price: 25 cents.

ABSTRACT

A key illustrated by photographs and brief descriptions is presented to aid in identifying the six species of angelfishes, family Pomacanthidae, found in the western Atlantic.

NOAA Technical Report NMFS CIRC-370. Kramer, David, Mary J. Kalin, Elizabeth G. Stevens, James R. Thailkill, and James R. Zweifel. **"Collecting and processing data on fish eggs and larvae in the California Current region."** November 1972. 38 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 50 cents.

ABSTRACT

Descriptions are given for the methods used by the California Cooperative Oceanic Fisheries Investigations to collect and process plankton. These include details of the design of the station pattern in the survey area, the gear and methods used for plankton hauls, measuring plankton, and sorting plankton for fish eggs and larvae; some procedures for identifying fish eggs and larvae; details of "hand" processing data for standardization of numbers of organisms collected in all plankton hauls; calibration of flowmeters; and some new procedures for automatic data processing.

NOAA Technical Report NMFS CIRC-372. Manar, Thomas A. **"Fishery publications, calendar year 1971: lists and indexes."** October 1972. 24 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 30 cents.

ABSTRACT

The following series of fishery publications of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, in calendar year 1971 are listed numerically (with abstracts) and indexed by author, subject, and geographic area: NOAA Technical Report CIRC (formerly Circular); Data Report; Fishery Leaflet; and NOAA Technical Report NMFS SSRF (formerly Special Scientific Report—Fisheries).

NOAA Technical Report NMFS CIRC-377. Engett, Mary Ellen, and Lee C. Thorson. **"Fishery publications, calendar year 1970: lists and indexes."** December 1972. 34 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 45 cents.

ABSTRACT

The following series of fishery publications of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration (until October, 1970 the Bureau of Commercial Fisheries of the U.S. Fish and Wilflife Service) in calendar year 1970 are listed numerically (with abstracts) and indexed by author, subject, and geographic area: Circular, Data Report, Fishery Industrial Research, Fishery Leaflet, and Special Scientific Report —Fisheries.

NOAA Technical Report NMFS SSRF-660. Ellis, James E., and Charles C. Hoopes. **"A Freshwater Fish Electro-Motivator (FFEM)—its characteristics and operation."** November 1972. 11 p.

ABSTRACT

A prototype Freshwater Fish Electro-Motivator (FFEM) system was developed as a research tool to test the application of electricity for use with active and passive fishing gear for increasing the gear's catching efficiency. The system's basic characteristics and operating modes are explained. The prototype system is extremely sophisticated, and its versatility permits single or multiple time-sequenced electrode loading and various pulse patterns, and allows duty cycles over a wide dynamic electrode load range. A summary of the field testing is discussed.

NOAA Technical Report NMFS SSRF-661. Hester, Frank J., and Tamio Otsu. **"A review of the literature on the development of skipjack tuna fisheries in the central and western Pacific Ocean."** January 1973. 13 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 25 cents.

ABSTRACT

There has been a rapid acceleration in efforts to develop skipjack tuna fisheries in the central and western Pacific. This is because the resources of the larger tunas (yellowfin, bigeye, bluefin, and albacore) are already being fished at or near the maximum sustainable level. The greatest potential for increased harvest appears to be the skipjack resource. To assist the skipjack development effort, pertinent information on the subject is summarized and a bibliography of selected references is included.

NOAA Technical Report NMFS SSRF-662. Wise, John P., and Charles W. Davis. **"Seasonal distribution of tuna and billfishes in the Atlantic."** January 1973. 24 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 35 cents.

ABSTRACT

Charts of the Atlantic Ocean for each quarter of the year—January-March, etc.—show the distribution of 10 species and groups of species fished by the Japanese Atlantic longline fishery in the years 1956-68. These charts are based on detailed catch and fishing effort data published by the Japanese Government. Quarterly average catch per unit of effort was calculated for each 5° × 5° square, and contour lines were drawn through equal levels of catch per unit of effort. The text explains the calculation and contouring processes in detail, and has a section of remarks and explanation for each of the 10 species or groups.

NOAA Technical Report NMFS SSRF-663. Waldron, Kenneth D. **"Fish larvae collected from the northeastern Pacific Ocean and Puget Sound during April and May 1967."** December 1972. 16 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 30 cents.

ABSTRACT

Fish larvae belonging to 24 families and the suborder Blennioidea were collected from Puget Sound and the Pacific Ocean off British Columbia, Washington, and Oregon during April and May 1967. All families and the Blennioidea were present in oceanic waters, but only 13 families and the Blennioidea were present in Puget Sound. The most abundant families in the oceanic area were Scorpaenidae, Myctophidae, and Pleuronectidae, whereas in Puget Sound the most abundant families were Gadidae, Pleuronectidae, and Scorpaenidae. Variations in composition and numbers of larvae in the catch were associated with area, water depth, water temperature, and time of day at which the collections were made.

NOAA Technical Report NMFS-664. Kroger, Richard L., and Robert L. Dryfoos. **"Tagging and tag-recovery experiments with Atlantic menhaden, *Brevoortia tyrannus*."** December 1972. 11 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

Laboratory tagging experiments with adult and juvenile Atlantic manhaden were conducted at Beaufort, N.C., in 1965 and 1969. Tag-recovery experiments were done at menhaden processing plants at Beaufort, N.C. Internal ferromagnetic body tags of appropriate sizes are suitable for tagging adults and juveniles, and the tags can be recovered effectively on magnets in the processing plants.

NOAA Technical Report NMFS SSRF-665. Eldridge, Maxwell B., and Charles F. Bryan. **"Larval fish survey of Humboldt Bay, California."** December 1972. 8 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 25 cents.

ABSTRACT

As part of a series of investigations of the marine resources of Humboldt Bay, Calif., a larval fish survey was conducted from January to December 1969. Bottom and oblique tows were made at five sampling stations with 1-m plankton nets on alternate biweekly intervals. Thirty-seven species of larval and juvenile fishes representing 17 families were collected. In terms of larval abundance, the dominant fish was the bay goby, *Lepidogobius lepidus*, followed by Pacific herring *(Clupea harengus pallasi)*, Pacific staghorn sculpin *(Leptocottus armatus)*, longfin smelt *(Spirinchus thaleichthys)* and the arrow goby *(Clevelandia ios)*. These five species constituted 95% of all larvae captured.

The number of larvae captured increased with increasing distance from the mouth of the Bay. The lowest number of species captured was at a station which experienced the widest range of salinities and temperatures. Peaks of seasonal abundance occurred in January and February and in April and May. Relatively few fish were captured after June. Some notable appearances of offshore spawned fishes were found in Humboldt Bay.

Data Report 75. Ingraham, W. James, Jr., Donald M. Fisk, Charles J. Bartlett, and Stephen E. Turner. **"Physical-chemical oceanographic data from the North Pacific Ocean and Bering Sea, 1971."** 169 p. (3 microfiche). For sale by U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22131. Accession No. COM-73-10192. Price: $0.95 (microfiche); $3.00 (hard copy).

ABSTRACT

Temperature and salinity data were obtained in the North Pacific Ocean at 176 stations in 1971 during spring and autumn cruises of the RV *George B. Kelez* south of the Aleutian Islands, in the Bering Sea, and along the coasts of Washington and British Columbia. Values were obtained from STD traces at standard depths to 1,000 m (spring data) or 1,500 m (autumn data). Computations of density (sigma-t), sound velocity, anomaly of specific volume, and dynamic height, which were performed by a shipboard PDP-8 computer, are also presented. The autumn data tabulations were obtained automatically through a new computer interface.

MFR: Its Readers and Staff

Recently I went through the distribution list of *Marine Fisheries Review* card by card to find out who is receiving the periodical. It seemed at first an astonishingly heterogeneous list. There were fishermen, M.D.'s, bankers, librarians, writers, lawyers; indeed there are few jobs and professions that are not represented among the readership. Yet when I got to thinking about it, a certain pattern did seem to appear. All of these people seem to be persons who earn their livelihood in some way from knowledge of the marine sciences or the sea and they are seeking specific information that will help them do their jobs better and do better in their jobs. Such an audience essentially establishes the editorial policy of the periodical. *Marine Fisheries Review*, I think, should attempt to bring factual material about the fisheries to the attention of people who can use such material profitably in their work. A tall order: certainly no one in the audience can be expected to read the periodical cover to cover. Only the editor, the typesetters, and proofreaders will do that. On the other hand, each member of the audience should find something in each issue that is useful to him. We hope that most of you will do so.

At the time of writing, four persons on the NMFS Scientific Publications Staff work on *Marine Fisheries Review*. They are, alphabetically, Mary Ellen Engett, myself, Harold L. Spiess, and Lee C. Thorson. Ms. Engett is a graduate of the University of Washington, with a B.A. in English; more recently she has earned an M.A.T. from Seattle University in English. Since joining the Scientific Publications Staff in June 1972, she and her co-worker, Lee C. Thorson, have prepared indexes to NMFS fishery publications for the years 1965 through 1970, and for the year 1972, and these are being printed in our NOAA Technical Report NMFS CIRC series. In addition, she helps keep our authors honest: with Mr. Thorson, she checks literature citations and other material in the hundreds of papers published by the Scientific Publications Staff. My own history is immensely longer. I spent about 15 years at the University of California's Scripps Institution of Oceanography and the later University of California, San Diego. I joined NMFS in 1965 and worked at the laboratory in Honolulu until 1970, when I became Chief, Scientific Publications Staff and moved to Seattle. Harold L. Spiess, a Visual Communication Specialist, received his training at the well-known Art Center School in Los Angeles. He joined the Scientific Publications Staff in 1971. Lee C. Thorson is a graduate of the University of Washington, where he took a degree in fisheries, and is a veteran of four years in the Air Force. Because of his background, he is the office expert on fisheries and mathematics. None of us, by the way, has worked full time on *Marine Fisheries Review*, for we all have other responsibilities. We are the ones to blame if things go wrong: if words are misspelled or sentences don't come out quite right, Mary Ellen and Lee will have to take the brunt of it; if a photograph of a flatfish is printed reversed (this has not happened only, I suspect, because we have as yet had no photographs of flatfishes—the error is the classical one in fishery publications) Hal will have to take the responsibility. If we print nonsense, the fault will be mine. All these catastrophes are endemic in publication: editors and their staffs must grow thick skins. I promise that we will do our best to avoid such editorial mishaps, however, and, when we are wrong, we will publicly—if reluctantly—admit it.

Engott

Manar

Spiess

Thorson

A note to potential authors: The columns of this publication are open to any author who has fresh material on marine fisheries to present (or a fresh viewpoint on older material). Manuscripts should be typed, double-spaced, and two copies should be submitted. The author is expected to have had his paper reviewed by competent authorities, but the editor reserves the right to ask for further review and to suggest alterations. Photographs and drawings should accompany the manuscript. Except in unusual instances, there should be no more than one illustration for every four double-spaced pages of text. Literature citations should have been verified by the author. The manuscripts should be addressed to the Editor, *Marine Fisheries Review*, NOAA, National Marine Fisheries Service, Room 450, 1107 N.E. 45th St., Seattle, WA 98105. Receipt of manuscripts will be acknowledged and the author will be notified within a few weeks whether his paper has been accepted. Authors who are members of NMFS should send a properly executed Manuscript Transmittal Form along with the manuscript.

T.A.M.

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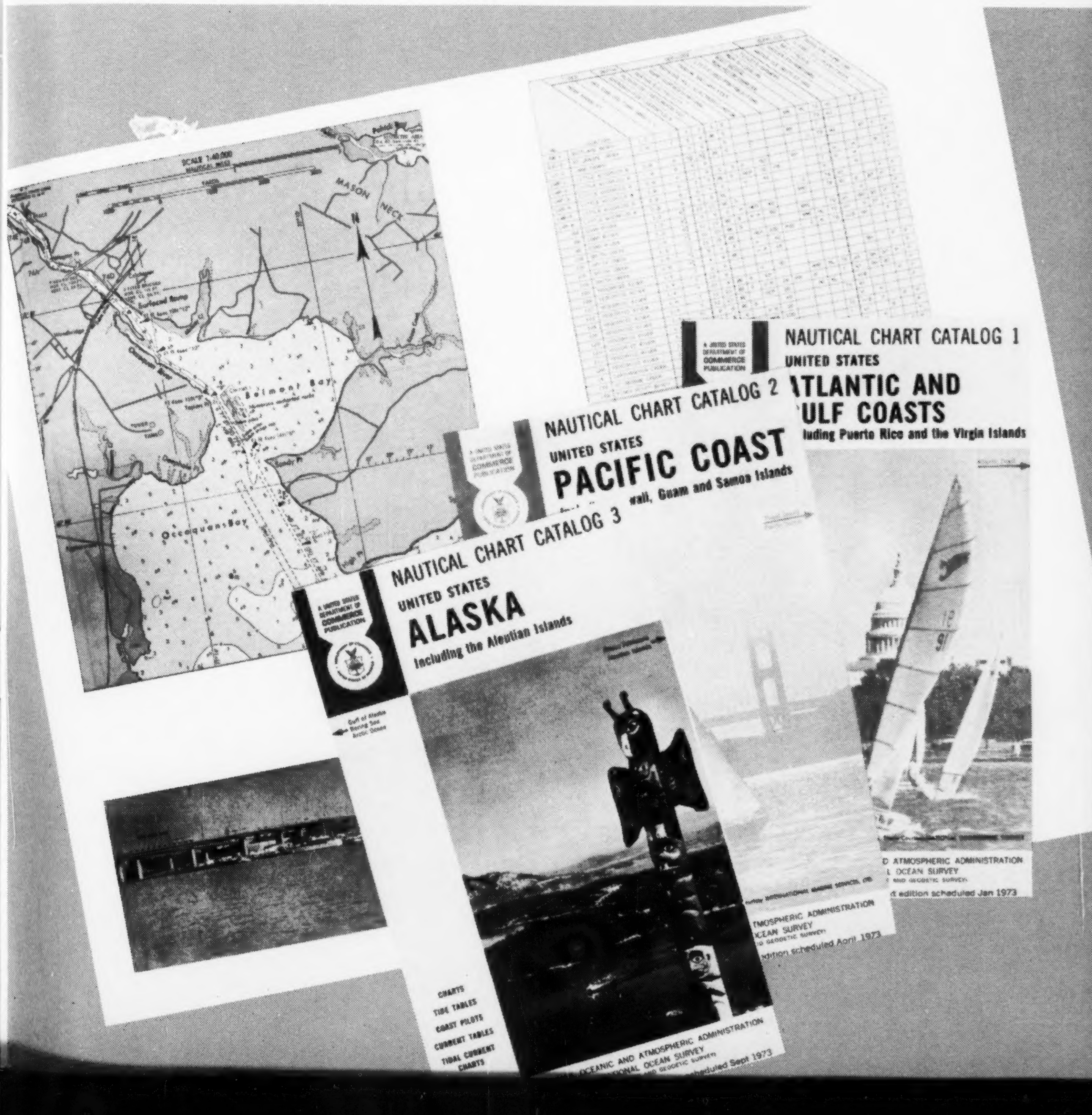

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